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NATIONAL DAM SAFETY PROGRAM. MARIAN LAKE DAM (MO 30016), MISSOU--ETC(U)
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MARIAN LAKE DAM
WARREN COUNTY, MISSOURI
MO. 30016

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PHASE I INSPECTION REPORT
NATIONAL DAM SAFETY PROGRAM

United States Army
Corps of Engineers
Serving the Army
Serving the Nation

St. Louis District

PREPARED BY: U. S. ARMY ENGINEER DISTRICT, ST. LOUIS

FOR: STATE OF MISSOURI

MAY 1981

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SECURITY CLASSIFICATION OF THIS PAGE (When Data Entered)

REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER	2. GOVT ACCESSION NO. AD-A104968	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) Phase I Dam Inspection Report National Dam Safety Program Marian Lake Dam (MO 30016) Warren County, Missouri		5. TYPE OF REPORT & PERIOD COVERED Final Report
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Consoer, Townsend and Associates, Ltd.		8. CONTRACT OR GRANT NUMBER(s) DACW43-80-C-0094
9. PERFORMING ORGANIZATION NAME AND ADDRESS U.S. Army Engineer District, St. Louis Dam Inventory and Inspection Section, LMSED-PD 210 Tucker Blvd., North, St. Louis, Mo. 63101		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS U.S. Army Engineer District, St. Louis Dam Inventory and Inspection Section, LMSED-PD 210 Tucker Blvd., North, St. Louis, Mo. 63101		12. REPORT DATE May 1981
		13. NUMBER OF PAGES Approximately 80
14. MONITORING AGENCY NAME & ADDRESS (if different from Controlling Office) National Dam Safety Program. Marian Lake Dam (MO 30016), Missouri - Kansas City River Basin, Warren County, Missouri. Phase I Inspection Report.		15. SECURITY CLASS. (of this report) UNCLASSIFIED
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Dam Safety, Lake, Dam Inspection, Private Dams

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report was prepared under the National Program of Inspection of Non-Federal Dams. This report assesses the general condition of the dam with respect to safety, based on available data and on visual inspection, to determine if the dam poses hazards to human life or property.

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DEPARTMENT OF THE ARMY
ST. LOUIS DISTRICT, CORPS OF ENGINEERS
210 TUCKER BOULEVARD, NORTH
ST. LOUIS, MISSOURI 63101

REPLY TO
ATTENTION OF

SUBJECT: Marian Lake Dam (Mo. 30016) Phase I Inspection Report

This report presents the results of field inspection and evaluation of the Marian Lake Dam (Mo. 30016).

It was prepared under the National Program of Inspection of Non-Federal Dams.

This dam has been classified as unsafe, emergency by the St. Louis District as a result of the application of the following criteria:

1) The spillway will not pass a 10-year frequency flood without overtopping of the dam. The spillway is, therefore, considered to be unusually small and seriously inadequate.

2) Overtopping of the dam could result in dam failure.

3) Dam failure significantly increases the hazard to loss of life downstream.

SUBMITTED BY: SIGNED — Chief, Engineering Division — Date: 9 JUN 1981

APPROVED BY: SIGNED — Colonel, CE, District Engineer — Date: 11 JUN 1981

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MARIAN LAKE DAM

WARREN COUNTY, MISSOURI

MISSOURI INVENTORY NO. 30016

PHASE I INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

PREPARED BY

PRC CONSOER TOWNSEND, INC.

ST. LOUIS, MISSOURI

AND

PRC ENGINEERING CONSULTANTS, INC.

ENGLEWOOD, COLORADO

A JOINT VENTURE

UNDER DIRECTION OF

ST. LOUIS DISTRICT, CORPS OF ENGINEERS

FOR

GOVERNOR OF MISSOURI

MAY 1981

PHASE I INSPECTION REPORT

NATIONAL DAM SAFETY PROGRAM

Name of Dam:	Marian Lake Dam, Missouri Inv. No. 30016
State Located:	Missouri
County Located:	Warren
Stream:	Unnamed tributary of Wolf Creek
Date of Inspection:	March 2, 1981

Assessment of General Condition

Marian Lake Dam was inspected by the engineering firms of PRC Consoer Townsend, Inc., of St. Louis, Missouri, and PRC Engineering Consultants, Inc., of Englewood, Colorado, (A Joint Venture) in accordance with the U. S. Army Corps of Engineers "Recommended Guidelines for Safety Inspection of Dams" and additional guidelines furnished by the St. Louis District of the Corps of Engineers. Based upon the criteria in the guidelines, the dam is in the high hazard potential classification, which means that loss of life and appreciable property loss could occur in the event of failure of the dam. Located within the estimated damage zone of four miles downstream of the dam are one lakeside building, nine dwellings, one downstream dam (Sherwood Lake Dam, Mo. 10202), one sewage treatment plant and one county highway, which may be subjected to flooding, with possible damage and/or destruction, and possible loss of life. Marian Lake Dam is in the intermediate size classification since it is more than 40 feet but less than 100 feet in height.

The inspection and evaluation indicates that the spillway of Marian Lake Dam does not meet the criteria set forth in the guidelines for a dam having the above size and hazard potential. Marian Lake Dam being an intermediate size dam with a high hazard potential is required by the guidelines to pass the Probable Maximum Flood (PMF) before overtopping of the dam occurs. Considering the number of inhabited dwellings located in the downstream hazard zone, the PMF is considered the appropriate spillway design flood for Marian Lake Dam. The Probable Maximum Flood is defined as the flood discharge that may be expected from the most severe combination of critical meteorological and hydrologic conditions that are reasonably possible in the region. It was determined that the reservoir/spillway system can accommodate approximately six percent of the Probable Maximum Flood without overtopping the dam. The evaluation also indicates that the reservoir/spillway system cannot accommodate the ten-percent chance flood without overtopping.

The overall condition of the dam appears to be fair; however, several deficiencies were noted by the inspection team. The deficiencies included: the seepage observed near the spillway, which should be investigated further; the erosion in the discharge channel of the spillway along the left abutment/embankment contact; the wet areas observed on the downstream slope; the collapsed portion of the spillway apron and the undermining and imminent failure of the remaining portion of the spillway apron; the need for proper protection around the inlet of the spillway pipes; the wave erosion observed on the upstream slope and at the toe of the dam; the observed mole activity on the top of the dam; a need for a well-maintained vegetative cover on the embankment slopes; and a need for periodic inspection by a qualified engineer. The lack of seepage and stability analyses on record is also a deficiency that should be corrected.

It is recommended that the owner take action to correct or control the deficiencies described above.

STATE OF MISSOURI
WALTER G SHIFRIN
NUMBER E-8834
REGISTERED PROFESSIONAL ENGINEER

Walter G. Shifrin, P.E.

Overview of Marian Lake Dam

NATIONAL DAM SAFETY PROGRAM

MARIAN LAKE DAM, I.D. No. 30016

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NATIONAL DAM SAFETY PROGRAM

MARIAN LAKE DAM, Missouri Inv. No. 30016

SECTION 1: PROJECT INFORMATION

1.1 General

a. Authority

The Dam Inspection Act, Public Law 92-367 of August, 1972, authorizes the Secretary of the Army, through the Corps of Engineers, to initiate a national program of dam inspections. Inspection for Marian Lake Dam was carried out under Contract DACW 43-80-C-0094 between the Department of the Army, St. Louis District, Corps of Engineers, and the engineering firms of PRC Consoer Townsend, Inc., of St. Louis, Missouri, and PRC Engineering Consultants, Inc., of Englewood, Colorado (A Joint Venture).

b. Purpose of Inspection

The visual inspection of Marian Lake Dam was made on March 2, 1981. The purpose of the inspection was to make a general assessment as to the structural integrity and operational adequacy of the dam embankment and its appurtenant structures.

c. Scope of Report

This report summarizes available pertinent data relating to the project, presents a summary of visual observations made during the field inspection, presents an assessment of hydrologic and hydraulic conditions at the site and of the structural adequacy of the various project features, and assesses the general condition of the dam with respect to safety.

Subsurface investigations, laboratory testing, and detailed analyses were not within the scope of this study. No warranty as to the absolute safety of the project features is implied by the conclusions presented in this report.

It should be noted that in this report reference to left or right abutments is viewed as looking downstream. Where left abutment or left side of the dam is used in this report, this also refers to the east abutment or side, and right to the west abutment or side.

d. Evaluation Criteria

The inspection and evaluation of the dam is performed in accordance with the U.S. Army Corps of Engineers "Recommended Guidelines for Safety Inspection of Dams" and additional guidelines furnished by the St. Louis District office of the Corps of Engineers for Phase I Dam Inspection.

1.2 Description of the Project

a. Description of Dam and Appurtenances

The following description is based upon observations and measurements made during the visual inspection, information obtained from a report prepared by Horner and Shifrin, Inc. of St. Louis, Missouri (see Section 2.1), and conversations with Messrs. Emerson

Sanders and George Schmidt, representatives of the owner. No design or "as-built" drawings were available for this dam.

The dam is a homogeneous, rolled, earthfill structure, according to Mr. Schmidt. The alignment of the dam is straight between earth abutments. A plan and elevation of the dam are shown on Plate 4 and Photos 1 through 3 show views of the dam. The top of dam was measured to be 415 feet long and 19 feet wide, except at the location of the spillway pipes where it widens to 25 feet. The top of dam was surveyed to be level from the left abutment to a point 70 feet to the left of the right abutment. From this point, the top of dam slopes upward with a rise in elevation of 2.2 feet to the right abutment/embankment contact. The minimum elevation of the top of dam was taken to be 673.5 feet above mean sea level (M.S.L.), which was obtained from the report by Horner and Shifrin, Inc. The embankment has a maximum structural height of 47.7 feet with side slopes of 1 vertical to 2 horizontal (1V to 2H) on the downstream face and 1V to 3H on the upstream face above the water surface.

The only spillway at this damsite consists of two corrugated metal pipe arches, 28 inches high and 42 inches wide, located near the left abutment of the dam (see Photo 6). The invert of the left pipe is at elevation 670.2 feet above M.S.L. and the invert of the right pipe is at elevation 669.6 feet above M.S.L. Both pipes are 32.5 feet long and coated with asphalt inside and outside. The pipes outlet onto a concrete apron. The apron is 13.5 feet long and varies in width from eight feet at the outlet of the pipes to 6.33 feet at the downstream end. Both sides of the apron are bordered by an eight inch high curb. The apron slab is six inches thick. An additional eleven feet at the downstream end of the apron has broken off and fallen into the spillway discharge channel. Downstream of the concrete apron the spillway channel is earth-lined. The channel follows the left abutment/embankment contact and discharges into the reservoir of Sherwood Lake Dam (Mo. 10202), directly downstream of the dam.

No low-level outlet or outlet works were provided for this dam, according to Mr. Sanders.

b. Location

Marian Lake Dam is located in Warren County in the State of Missouri on an unnamed tributary of Wolf Creek. The dam is located approximately 10.5 miles south of Foristell and six miles southwest of New Melle in the southwest quadrant of Section 12 of Range 1 West, Township 45 North, as shown on the New Melle, Missouri Quadrangle (7.5 minute series) sheet (see Plate 2).

c. Size Classification

The reservoir impoundment of Marian Lake Dam is less than 1,000 acre-feet but more than 50 acre-feet, which would classify it as a "small" size dam. The maximum structural height of the dam is less than 100 feet and greater than 40 feet, which classifies it as an "intermediate" size dam. The size classification is determined by either the storage or height, whichever gives the larger size category. Therefore, the size classification is determined to fall within the "intermediate" category, according to the "Recommended Guidelines for Safety Inspection of Dams" by the U.S. Department of the Army, Office of the Chief Engineer.

d. Hazard Classification

The dam has been classified as having a "high" hazard potential in the National Inventory of Dams, on the basis that in the event of failure of the dam or its appurtenances, excessive damage could occur to downstream property, together with the possibility of the loss of life. From a visual inspection of the downstream area, our findings partially concur with this classification as listed in the National Inventory of Dams. Located within the estimated damage zone, which extends less than one mile downstream of the dam, are at least one lakeside building, which houses the

office for the Lake Sherwood Estates Association, and three Lakeside dwellings (see Photos 13 and 14).

The estimated damage zone, however, as listed in the National Inventory of Dams and described above is based upon the assumption that any floodwaters passing through Lake Marian would be contained within the reservoir of Sherwood Lake Dam (Mo. 10202) located approximately one mile downstream. However, it is felt that Sherwood Lake Dam would be affected by the combination of a failure of Marian Lake Dam and the occurrence of a Probable Maximum Flood. This would extend the estimated damage zone three miles further downstream and include an additional six dwellings, one sewage treatment plant and one county highway. Therefore, the downstream hazard zone is changed to include one lakeside building, nine dwellings, Sherwood Lake Dam (Mo. 10202), one sewage treatment plant and one county highway all of which are located within a damage zone that extends at least four miles downstream of the dam.

e. Ownership

Marian Lake Dam is privately owned by Lake Sherwood Estates Association of Lake Sherwood, Missouri. The mailing address is as follows: Mr. Emerson P. Sanders, Executive Director, Lake Sherwood Estates Association, P.O. Box 85, Lake Sherwood, Missouri, 63357.

f. Purpose of Dam

The purpose of the dam is to impound water for recreational use as a private lake.

g. Design and Construction History

According to Mr. Sanders, the construction of the dam was started in 1965 and completed in early 1966 by Mertens Construction Company of Fulton, Missouri. The original owner of Lake Sherwood Estates, who was an engineer, and Mertens Construction Company did the engineering for the dam, according to Mr. Sanders. However, no drawings or specifications used for the construction of Marian Lake Dam exist.

h. Normal Operational Procedures

Normal operational procedure is to allow the reservoir to remain as full as possible. The water level is controlled by rainfall, runoff, evaporation, and the invert elevations of the spillway pipes. A staff gage located near the inlet of the spillway pipes is used by Lake Sherwood Estates employees to monitor the lake level on a weekly basis.

1.3 Pertinent Data

a. Drainage Area (square miles): . . . 0.23

b. Discharge at Damsite

Estimated experienced maximum flood (cfs):	11
Estimated ungated spillway capacity with reservoir at top of dam elevation (cfs):	126

c. Elevation (Feet above MSL)*

Top of dam (minimum):	673.5
Spillway crests:	669.6 and 670.2
Normal Pool:	669.6
Maximum Experienced Pool:	670.6
Observed Pool:	666.5

d. Reservoir

Length of pool with water surface at top of dam elevation (feet):	1600

e. Storage (Acre-Feet)

Top of dam (minimum):	147.0
Spillway crests:	118.5 and 123.0
Normal Pool:	118.5
Maximum Experienced Pool:	126.0
Observed Pool:	97.2

f. Reservoir Surfaces (Acres)

Top of dam (minimum):	9.5
Spillway crests:	8.0 and 8.2
Normal Pool:	8.0
Maximum Experienced Pool:	8.4
Observed Pool:	7.2

g. Dam

Type:	Rolled, Earthfill
Length:	415 feet
Structural Height:	47.7 feet
Hydraulic Height**:	47.7 feet
Top width:	19 feet
Side slopes:	
Downstream	1V to 2H
Upstream	1V to 3H (Above the water surface)
Zoning:	N.A., Homogeneous
Impervious core:	N.A.
Cutoff:	A trench was excavated to bedrock, according to Mr. Schmidt.
Grout curtain:	None
Volume:	59,000 cu.yds. (Estimated)

h. Diversion and Regulating Tunnel . . . . None

i. Spillway

Type:	Two, 42 inch by 28 inch corrugated metal pipe arches.
Length of crest:	N.A.
Crest Elevations (feet above MSL):	669.6 and 670.2

j. Regulating Outlets . . . None

* Exact elevations for the spillway pipes and the top of dam were taken from a report prepared by Horner and Shifrin, Inc. Relative differences between the given elevations were field verified by use of surveying equipment.

** The hydraulic height of the dam is the vertical distance from the lowest point on the downstream toe to the top of dam or the maximum water surface, if below the top of dam.

SECTION 2: ENGINEERING DATA

2.1 Design

According to Mr. Sanders, the original owner of Lake Sherwood Estates, who was an engineer, and Mertens Construction Company designed Marian Lake Dam. However, no design drawings or specifications were available for the dam.

A hydraulic/hydrologic report prepared by Horner and Shifrin, Inc., entitled, "Evaluation of the Spillway Capacities of the Lakes in Lake Sherwood Estates" and dated March 13, 1978 was available for review by the inspection team. Pertinent information was obtained from this report and used in the preparation of this Phase I inspection report. The information consisted of reservoir elevation-area-capacity data, elevations and drainage basin data (see Plates 11 through 17). The information was verified from field measurements and by use of the U.S.G.S. New Melle, Missouri Quadrangle topographic map (7.5 minute series).

2.2 Construction

No documented data concerning the construction of the dam was available for this report; however, information concerning the construction of the dam was obtained through conversations with Mr. Schmidt, construction and maintenance manager at Lake Sherwood Estates. Mr. Schmidt stated that the compaction of the embankment was achieved by the activity of the earthmoving equipment across the embankment; no compaction control was employed. A cutoff trench was excavated to solid bedrock. A layer of sand was placed on the top and upstream slope of the dam to create a beach and boat unloading area.

2.3 Operation

There are no low-level outlets or control structures for Marian Lake Dam. The lake level is allowed to remain as full as possible. A staff gage is used by Lake Sherwood Estates employees to weekly monitor and record the lake water level. The water level below the crest of the spillway pipes is controlled by rainfall, runoff and evaporation.

2.4 Evaluation

a. Availability

The availability of engineering data consists of a soil survey by the Soil Conservation Service for Warren County, State Geological Maps, U.S.G.S. Quadrangle sheets and a report prepared in 1978 by Horner and Shifrin, Inc., of St. Louis, Missouri, entitled, "Evaluation of the Spillway Capacities of the Lakes in Lake Sherwood Estates". The pertinent information obtained from the report mentioned above are included in this report. No data were available with regard to subsurface investigations or soil testing for the dam.

b. Adequacy

The lack of engineering data did not allow for a definitive review and evaluation. Therefore, the adequacy of this dam could not be assessed from the standpoint of reviewing and evaluating design, operation, and construction data, but is based primarily on visual inspection, past performance history, and present condition of the dam. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available, which is considered a deficiency. These seepage and stability analyses should be performed for appropriate loading conditions (including earthquake loads) and made a matter of record.

c. Validity

The only valid engineering data is the report prepared by Horner and Shifrin, Inc., entitled, "Evaluation of the Spillway Capacities of the Lakes in Lake Sherwood Estates". Information obtained from the Horner and Shifrin report and used in the preparation of this Phase I inspection report was verified and shown to be valid.

SECTION 3: VISUAL INSPECTION

3.1 Findings

a. General

A visual inspection of the Marian Lake Dam was made on March 2, 1981. The following persons were present during the inspection:

Name	Affiliation	Disciplines
Mark Haynes, P.E.	PRC Engineering Consultants, Inc.	Soils
Jerry Kenny	PRC Engineering Consultants, Inc.	Hydraulics and Hydrology
James Nettum, P.E.	PRC Engineering Consultants, Inc.	Civil-Structural and Mechanical
Razi Quraishi, R.P.G.	PRC Engineering Consultants, Inc.	Geology
John Lauth, P.E.	PRC Consoer Townsend, Inc.	Civil-Structural
Emerson Sanders	Owner's Representative	
George Schmidt	Owner's Representative	

Specific observations are discussed below.

b. Dam

The overall condition of the dam appears to be fair; however, some items of concern were noted and are discussed below.

A one-foot layer of sand was placed on the upstream slope and the top of dam to create a beach area for the reservoir, according to Mr. Schmidt. Due to the layer of sand, a sparse growth of grass cover was observed on the slope and the top of dam. Nevertheless, no erosion due to surface runoff was noted in either area and it is felt that surface erosion will not be a problem in the future in these areas.

The top of dam showed no signs of cracking or depressions, which would indicate a settlement of embankment. No significant deviation in the vertical or horizontal alignment was observed, other than the change in elevation near the right abutment. It appears that the top of dam was constructed this way to gain access to the dam from the right abutment. Vehicular traffic across the dam except for occassional maintenance and construction equipment is prevented. According to Mr. Sanders, the dam has never been overtopped and no evidence indicating the contrary was observed.

The upstream slope has no riprap protection (see Photo 1). Consequently, some very minor erosion has occurred due to wave action. Cattails were growing in one area on the slope near the water surface level on the day of the inspection. The cattails appeared to be providing some protection against wave erosion for the upstream slope. No bulges, depressions, or cracks indicative of an instability of the slope were observed.

The downstream slope has a sparse vegetative cover; however, only minor erosion due to surface runoff was observed. Small saplings and brush appeared to have been growing on the slope at one time. The saplings were cut down and the brush was burnt off the slope. The slope was fairly irregular in some areas but the

irregularity of the slope did not appear to be due to any slope movements. No major bulges, depressions, or cracking indicative of embankment or foundation movement were apparent.

A sewer pipe was placed recently along the downstream, embankment/right abutment contact. The excavation for the pipe and construction access road cut into the embankment (see Photo 5). An approximate one-foot-high scarp was observed on the left side of this area indicating that the disturbed area was not restored to its original condition; however, the disturbed soil appears to have been recompacted. The removal of embankment material in this area, however, appears to have little or no effect on the stability of the embankment.

Along the downstream, embankment/left abutment contact, discharges through the spillway have eroded the embankment creating a discharge channel for the spillway (see Photos 9 and 10). The discharge channel was measured to be up to four feet deep and ten feet wide in one area. Along this same embankment/abutment contact, seepage was observed discharging from the embankment just downstream of the concrete apron of the spillway and flowing along the channel mentioned above. The flow rate of the seepage was estimated to be less than two gallons per minute. The discharge was clear and did not appear to be transporting any soil particles; however, to the left of the spillway a small depression was observed which could indicate that some displacement of the embankment materials has occurred in the past.

At the toe of the dam, a two-foot high, 20 foot wide, dish-shape, erosional scarp was observed (see Photo 4). The scarp appeared to be caused by wave action from the downstream reservoir when the water surface in the reservoir is at its normal level. In this same area, several wet spots were observed on the embankment. When digging a hole in these wet areas, the hole would quickly fill up with water, which would indicate a possibility of seepage through the embankment. Nevertheless, no measurable flow of water was

observed discharging from these areas. Several other wet areas were observed on the downstream slope in different locations.

According to Mr. Sanders, they do not have a problem with muskrats in the reservoir. No evidence of burrowing animals was observed on the upstream and downstream slopes or the abutments; however, evidence of mole activity was observed on the top of the dam.

Both abutments slope moderately upward from the top of dam. No instabilities or erosion due to surface runoff were observed on either abutment. No major problems were observed on either abutment except for the problems on the downstream, embankment/abutment contacts mentioned above. Sewer pipes were constructed through both abutments.

c. Project Geology and Soils

(1) Project Geology

The damsite is located on an unnamed tributary of Wolf Creek in the Springfield Plateau section of the Ozark Plateaus Physiographic Province. The Springfield Plateau includes that part of the Ozarks which is underlain mainly by rocks of the Mississippian age. Most of the Springfield Plateau are prairies, which are separated by valleys cut 200 to 300 feet below the upland surface. Most of the area of the Springfield Plateau is overlain by a mantle of chert derived by weathering of the Mississippian Limestone. Widespread distribution of dolomites and limestone bedrock with deep dissection is responsible for the development of many springs in the regional area of the damsite. A major component of surface discharge of water to the regional drainage is contributed by these springs.

The topography at the damsite vicinity is rolling to hilly with U-to V-shaped valleys. Elevations of the ground surface range from 824 feet above M.S.L. approximately 0.65 miles northwest of the damsite to 670 feet above M.S.L. at the damsite. The reservoir slopes are generally from 15 degrees to 20 degrees from horizontal. The reservoir slopes are stable and the reservoir appears to be watertight. The area near the damsite is covered with glacial-fluvial deposits and residual soils consisting of reddish brown, medium plastic, silty clay with occassional chert and limestone fragments.

The regional bedrock geology beneath the glacial-fluvial and the residual soils deposits in the damsite area as shown on the Geologic Map of Missouri (1979) (see Plate 7), consist of Pennsylvanian age rocks of the Cherokee Group; Mississippian age rocks consisting of Burlington Limestone and Hannibal Formation (shale and siltstone); and Ordovician age rocks consisting of Noix Limestone, Kimmswick Limestone, and St. Peter Sandstone. The predominent bedrock underlying the glacial-fluvial and the residual soil deposits in the vicinity of the damsite are the Pennsylvanian age rocks of the Cherokee Group and Mississippian age Burlington Limestone.

Outcroppings of Pennsylvanian Cherokee Group rocks (cyclic deposits of brownish-gray, fine to medium grained, hard, unweathered, sandy limestone interbedded with shale and limestone) and Mississippian Burlington Limestone (brownish-gray, fine to medium grained, hard, unweathered cherty limestone) are exposed in the discharge channel of the spillway and on the western and eastern rim of the Marian Lake (see Photo 11).

No faults have been identified in the vicinity of the damsite. The closest trace of a fault to the damsite is the Moselle fault nearly 15 miles south of the damsite. The Moselle fault had its last movement in post-Early Ordovician time. Thus, the fault has no effect on the damsite.

No boring logs or construction reports were available that would indicate foundation conditions encountered during construction. Based upon the visual inspection and conservations with Mr. Schmidt, the embankment probably rests on brownish-gray, fine to medium grained, hard, unweathered, sandy limestone and the corrugated metal pipe arches of the spillway rest on the compacted embankment fill.

(2) Project Soils

According to the "Soil Survey of Montgomery and Warren Counties, Missouri", published by the Soil Conservation Service in 1978, the soils in the general area of the dam belong to the Goss-Gasconade-Chilhowie association. The soils at the damsite consist of the Goss very cherty silt loam, Gasconade stony silty clay loam and the Gasconade-Rock outcrop complex. These soils are basically formed from weathered limestone and thinly interbedded shale.

Materials removed from the downstream slope of the embankment appeared to be a light brown, moderately plastic, silty clay with traces of fine to medium sand. Based upon the Unified Soil Classification System, the soil would probably be classified as a CL. This is an impervious soil type, which generally has the following characteristics: a coefficient of permeability less than 1.0 foot per year, medium shear strength, and a high resistance to piping. This soil type also has a high resistance to erosion under low velocity flow; however, excessive erosion can occur during the high velocity flows that can be expected when the dam is overtopped.

d. Appurtenant Structures

(1) Spillway

The spillway pipes appear to be in fair condition. The asphalt coating is sloughing off in some places. The inlet ends of both pipes are slightly deformed but the pipes are unobstructed and should function properly. No erosion of the embankment at the inlet

of the pipes is evident although this area is not protected by riprap or a headwall.

The surface of the concrete outlet apron is rough and pitted due mainly to troweling technique at the time of the placement of the concrete and not by weathering. The apron concrete was placed without using concrete forms. The overall appearance of the concrete workmanship is very unprofessional. The lower 11 feet of the apron has broken off and fallen into the eroded discharge channel. There is no evidence of steel reinforcement at the break point in the apron. The portion of the apron still in place is undermined to a point 4.5 feet from the break point. The apron slab has a deep transverse crack starting 2.67 feet from the right spillway pipe and extending to 5.3 feet from the left spillway pipe (see Photo 8). The slab is displaced about one-half to one inch at the crack. The earth-lined channel just downstream of the apron is severely eroded to depths of four feet. Small trees and brush are growing in and along the sides of the earth-lined part of the channel. The undermining of the apron, and subsequent erosion of the discharge channel appears to have resulted from discharge from the two spillway pipes and further aggravated by the seepage through the embankment.

The present alignment of the discharge channel following the left abutment/embankment contact may not have been the original condition. There is some evidence that the discharge channel was intended to be aligned perpendicular to the axis of the dam to a point past the toe of the embankment. Sloughing of the channel bank may have blocked this path just downstream of the failed apron. Discharge from the spillway and the continuous seepage flow may have created the existing discharge channel alignment.

(2) Outlet Works

No low-level outlet or outlet works were provided for this dam.

e. Reservoir Area

The reservoir water surface elevation at the time of the inspection was 666.5 feet above M.S.L. The normal water surface in the reservoir is assumed to be at an elevation of 669.6 feet above M.S.L., which is the invert of the lowest spillway pipe. However, according to Mr. Sanders, the water level in the reservoir has generally been two to three feet below the elevation of the spillway in recent years. The surface area of the reservoir at the assumed normal water level is 8.0 acres.

The rim appeared to be stable with no erosional or stability problems observed. The land around the reservoir slopes moderately upward from the rim and is mostly wooded. Some homes are built around the rim. Several rock outcrops were observed on the rim in the vicinity of the damsite. No evidence of excessive siltation was observed in the reservoir.

One small dam (Eleanor Lake Dam, Mo.30015) is located at the upper reach of the reservoir (see Plate 2). The dam is large enough to be considered in the flood routing evaluation for Marian Lake Dam as further discussed in Section 5. A plan and elevation of the dam are shown on Plate 6.

f. Downstream Channel

There is no downstream channel. The spillway discharges directly into the reservoir of Sherwood Lake Dam (Mo. 10202)

3.2 Evaluation

The visual inspection did not reveal any conditions that were felt to pose an immediate threat to the safety of the structure; however, the following condition does exist, which would warrant prompt attention.

The seepage observed near the spillway poses a potential danger to the structural integrity of the dam. Although on the day of the inspection the seepage was clear and apparently not carrying any soil particles, it is highly possible that the flow rate of the seepage could increase. An increase in flow rate could transport soil particles, which could cause piping of the embankment material. This could eventually lead to the failure of the embankment in this area.

The following conditions also existed which could affect the safety of the dam.

1. The alignment of the discharge channel following the abutment/embankment contact is not a preferred condition. The continued erosion of the earth-lined discharge channel could have detrimental effects on the downstream slope of the dam. The presence of tree and brush roots and stalks in the channel will result in flow irregularities aggravating the erosion problem and offsetting whatever stabilizing effect the vegetative cover might provide.

2. The erosional scarp caused by wave action at the toe of the dam does not appear to affect the stability of the dam in its present condition. Nevertheless, continual erosion in this area can only be detrimental to the stability of the dam.

3. The wet spots observed on the downstream slope do not appear to effect the safety of the dam in their present condition. Nevertheless with time, the conditions could develop into a potential problem.

4. The undermining and resultant transverse crack pose a very real and imminent threat to the stability of the remaining portion of the spillway apron. The failure of the apron and progressive erosion in the spillway discharge channel will jeopardize the stability of the spillway pipes and therefore the dam.

5. The lack of proper protection at the spillway inlets has not resulted in embankment erosion although prolonged use of the spillways under high flow conditions could result in embankment material being swept into the spillway.

6. Due to the location of the observed mole activity, it is felt that the burrows created by the moles pose no danger to the safety of the dam. Nevertheless, if the moles were to migrate to other areas of the dam, it is possible they could jeopardize the safety of the dam. The holes created by any burrowing animal provide possible avenues for piping of the embankment material.

7. The very minor wave erosion on the upstream slope does not affect the stability of the dam in its present condition. Nevertheless, continual erosion of the slope can only be detrimental to the stability of the dam.

SECTION 4: OPERATIONAL PROCEDURES

4.1 Procedures

There are no specific procedures that are followed for the operation of the dam. The water level below the crest of the spillway pipes is controlled by rainfall, runoff, and evaporation.

4.2 Maintenance of Dam

The dam is maintained by employees of Lake Sherwood Estates. The grass on the upstream slope and the top of dam is mowed periodically. The downstream slope is also sprayed yearly with a herbicide to remove bushes and saplings from the slope and, occasionally, the bushes and saplings are burnt off the slope.

4.3 Maintenance of Operating Facilities

There are no operating facilities associated with this dam.

4.4 Description of Any Warning System in Effect

Marian Lake Dam is part of a system of five dams in the Lake Sherwood Estates in which a warning system has been developed in case of a failure of the lower dam (Sherwood Lake Dam). The warning system consists of a daily inspection by Lake Sherwood maintenance personnel of all the Lake Sherwood Estates dams. A listing of phone numbers for the local and county police and local fire departments, and the residents living downstream of Sherwood Lake Dam has been compiled as part of the warning system. The downstream residents would be warned of an impending dam failure by phone or by the fire or police departments. The Lake Sherwood Fire Department siren system can also be actuated by Mr. Sanders, or Lake Sherwood Estates personnel in order to also warn downstream residents of a dam failure.

4.5 Evaluation

The maintenance at Marian Lake Dam appears to be fair. Although the dam does not appear to be neglected, the remedial measures described in Section 7 should be undertaken to improve the condition of the dam.

SECTION 5: HYDRAULIC/HYDROLOGIC

5.1 Evaluation of Features

a. Design

Data from the report prepared by Horner and Shifrin, Inc. (see Plates 11 through 17) was used in evaluating the hydrologic/hydraulic adequacy of Marian Lake Dam and the upstream dam, Eleanor Lake Dam. The sizes of physical features utilized to develop the stage-outflow relation for the spillway and overtopping of each of the dams were prepared from field notes and sketches prepared during the field inspection and checked against data available in the report. The reservoir elevation-area-capacity data and drainage areas were taken from the report and verified from the U.S.G.S. New Melle, Missouri Quadrangle topographic map (7.5 minute series). The spillway and overtop release rates and the reservoir elevation-capacity data are presented in Appendix B.

The hydrologic soil groups of the two watersheds, one above the upstream dam and the other between the upstream dam and Marian Lake Dam were determined from information available in the U.S.D.A. Soil Conservation Service publication "Missouri General Soil Map and Soil Association Descriptions", 1979. The Probable Maximum Precipitation (PMP) used to determine the Probable Maximum Flood (PMF) was determined by using the U.S. Weather Bureau publication, "Hydrometeorological Report No. 33" (April, 1956). The 100-year and the 10-year floods were derived from the 100-year rainfall and the 10-year rainfall, respectively, of Warrenton, Missouri.

b. Experience Data

Weekly records of reservoir stage are maintained for this site. According to Mr. Sanders, the maximum reservoir level has been about 12 inches above the invert of the lower spillway pipe on two occasions.

c. Visual Observations

Observations made of the spillway during the visual inspection are discussed in Section 3.1d and evaluated in Section 3.2.

d. Overtopping Potential

Both the Probable Maximum Flood, and one-half of the Probable Maximum Flood when routed through the reservoir, resulted in overtopping of the dam. The peak inflows for the PMF and one-half of the PMF are 2476 cfs and 1117 cfs, respectively. The peak outflow discharges for the PMF and one-half of the PMF are 2337 and 1004 cfs, respectively. The maximum capacity of the spillway just before overtopping the dam is 126 cfs. The PMF overtopped the dam by 1.54 feet and one-half of the PMF overtopped the dam by 0.78 feet. The total duration of overflow over the top of dam is 8.67 hours during the PMF and 6.50 hours during one-half of the PMF. The spillway/reservoir system of Marian Lake Dam is capable of accommodating a flood equal to approximately six percent of the PMF just before overtopping the dam. The reservoir/spillway system of Marian Lake Dam will not accommodate the ten-percent chance flood without overtopping the dam. Marian Lake Dam may be susceptible to erosion due to high velocity flow on its downstream slope, which could lead to an eventual failure of the dam during overtopping of the dam.

The failure of the dam could cause extensive damage to the property downstream of the dam and possible loss of life. The estimated damage zone extends approximately four miles downstream of the dam. Located within the damage zone are one lakeside building, nine dwellings, one downstream dam, one sewage treatment plant, and one county highway.

Eleanor Lake Dam (Mo. 30015) mentioned in Section 3.1e has been included in determining the overtopping potential of Marian Lake Dam. This analysis included the hypothetical breach of Eleanor Lake Dam for those floods during which it was overtopped. Due to the complete obstruction of the spillway pipes (see Plate 6), the upstream dam was overtopped and breached by every flood, including the ten-percent chance flood. The sudden release of the water stored in the upstream reservoir was a major factor in the determination of the unusually small spillway capacity for Marian Lake Dam.

SECTION 6: STRUCTURAL STABILITY

6.1 Evaluation of Structural Stability

a. Visual Observations

There were no major signs of settlement or distress observed on the embankment or foundation during the visual inspection. The flowing seepage and the wet spots on the downstream slope could be detrimental to the stability of the embankment. Nevertheless, the seepage does not appear to constitute an unsafe condition at this time. The very minor wave erosion on the upstream slope, the erosion in the discharge channel of the spillway and the erosional scarp at the toe of the downstream slope do not appear to have adversely affected the stability of the dam at this time. However, continual erosion of the embankment in these areas can only jeopardize the structural integrity of the dam. In the absence of seepage and stability analyses, no quantitative evaluation of the structural stability can be made.

The structural stability of the spillway is in jeopardy due to the imminent failure of the outlet apron. Undermining due to discharge through the spillway and aggravated by the seepage has led to the failure of the lower 11 feet of the original 24.5 feet apron. A transverse crack and some displacement of the slab indicate a large portion of the remaining apron is failing. Operation of the spillway pipes will accelerate the failure of the remaining portion of the apron leaving the embankment at the spillway outlet unprotected and vulnerable.

b. Design and Construction Data

No design computations pertaining to the embankment were uncovered during the report preparation phase. Seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" were not available. No embankment or foundation soil parameters were available for carrying out a conventional stability analysis on the embankment. No construction data or specifications relating to the degree of embankment compaction were available for use in a stability analysis.

c. Operating Records

Water levels in the reservoir are recorded periodically and according to Mr. Sanders, the water level has generally been two to three feet below the invert of the lowest spillway pipe in recent years. Since there is no means to rapidly drawdown the reservoir, the loss of water from the reservoir is due to evaporation and the observed seepage through the embankment. This would have no effect on the stability of the dam from the standpoint of the reservoir being drawn down. The water level on the day of the inspection was 3.1 feet below the crest of the lowest spillway pipe.

d. Post Construction Changes

No post construction changes to the embankment are known to exist that will affect the structural stability of the dam except for the construction of the sewer pipe along the right abutment. However, the excavation does not appear to have affected the structural stability of the dam.

e. Seismic Stability

The dam is located in Seismic Zone 2, as defined in the "Recommended Guidelines For Safety Inspection of Dams" as prepared by the Corps of Engineers (see Plate 10). Seismic Zone 2 is characterized by a moderate earthquake hazard. An earthquake of the magnitude that would be expected in Seismic Zone 2 should not cause

significant distress to a well designed and constructed earth dam. Available literature indicates that no active faults exist near the vicinity of the damsite. The maximum recorded historic magnitude earthquake in the immediate vicinity of the damsite was the January 24, 1902 event of magnitude 5 located at a distance of 33 miles southeast of the damsite. This event cannot be correlated with known tectonic structure and is considered to probably be related to the release of accumulated residual strain along the buried pre-Quaternary fault. The attenuation of this event to the damsite would produce a peak ground acceleration of less than 0.05g which could not produce a significant seismic impact on the dam.

SECTION 7: ASSESSMENT/REMEDIAL MEASURES

7.1 Dam Assessment

The assessment of the general condition of the dam is based upon available data and visual inspection. Detailed investigations, testing, and detailed computational evaluations are beyond the scope of a Phase I investigation; however, the investigation is intended to identify any need for such studies.

It should be realized that the reported condition of the dam is based upon observations of field conditions at the time of the inspection along with data available to the inspection team.

It is also important to realize that the condition of a dam depends upon numerous and constantly changing internal and external conditions, and is evolutionary in nature. It would be incorrect to assume that the present condition of the dam will continue to represent the condition of the dam at some point in the future. Only through continued care and inspection can there be assurance that an unsafe condition could be detected.

a. Safety

The spillway capacity of Marian Lake Dam is found to be unusually small and seriously inadequate. The spillway/reservoir system will accommodate about six percent of the PMF without overtopping the dam. If the dam is overtopped, the safety of the embankment would be in jeopardy. Due to the susceptibility of the embankment materials to erosion, high velocity flow on the downstream slope could cause excessive erosion and eventually lead to a failure of the dam. The spillway system would also receive further damage during the occurrence of a PMF.

The overall condition of the dam appears to be fair; however, some items of concern were noted that will require attention. A quantitative evaluation of the safety of the embankment could not be made in view of the absence of seepage and stability analyses. The present embankment and spillway, however, have reportedly performed satisfactorily since their construction without failure or evidence of instability except for the collapsed portion of the spillway apron. The dam has never been overtopped, according to Mr. Sanders, and no evidence indicating the contrary was observed. The safety of the dam can only be improved if the deficiencies described in Sections 3.2 and 6.1a are properly corrected as described in Section 7.2b.

b. Adequacy of Information

Pertinent information relating to the design of the dam and spillway is completely lacking. The conclusions presented in this report are based on field measurements, past performance and present condition of the dam, and information obtained from the hydraulic/hydrologic report prepared by Horner and Shifrin, Inc. The pertinent information obtained from the report and used in this Phase I inspection report were field verified and checked using available data. The information used appeared to be accurate and adequate for use in this report. Information on the design hydrology, and hydraulic design, as well as seepage and stability analyses were not available for review. Lack of seepage and stability analyses comparable to the requirements of the "Recommended Guidelines for Safety Inspection of Dams" is considered a deficiency.

c. Urgency

The items recommended in paragraph 7.2a and the first item in paragraph 7.2b should be pursued on a high priority basis. The remaining remedial measures recommended in Paragraph 7.2 should be accomplished within a reasonable period of time.

d. Necessity for Phase II Inspection

Based upon results of the Phase I inspection, and if the remedial measures recommended in Paragraph 7.2 are undertaken, a Phase II inspection is not felt to be necessary.

7.2 Remedial Measures

a. Alternatives

There are several options that may be considered to reduce the possibility of dam failure or to diminish the harmful consequences of such a failure. Some of these options are:

1. Increase the spillway capacity to pass the PMF, without overtopping the dam.

2. Increase the height of the dam in order to pass the PMF without overtopping the dam; an investigation should also include studying the effects that increasing the height of the dam would have on the structural stability of the present embankment. The overtopping depth during the occurrence of the PMF, stated in Section 5.1d, is not the required or recommended increase in the height of the dam.

3. A combination of 1 and 2 above.

b. O & M Procedures

1. Further investigation of the seepage observed near the spillway should be undertaken to determine the seriousness of the seepage. The area should also be monitored to determine if the seepage is transporting embankment material. The investigation should be carried out under the direction of a qualified professional engineer and repairs made as required.

2. The erosion in the discharge channel of the spillway along the left abutment/embankment contact should be properly backfilled and compacted. The area should then be protected from further erosion due to discharges through the spillway and discharges through the spillway should be directed away from this area.

3. The wet spots on the downstream slope should be monitored to detect any flow of water or changes in location of the areas. Any changes in the condition of the wet spots should be investigated further by a qualified, professional engineer.

4. The remaining portion of the spillway apron should be removed, the eroded area backfilled and compacted and a new reinforced concrete apron provided.

5. Proper protection should be placed around the inlet on the spillway pipes to prevent erosion of the embankment during high flows.

6. The very minor wave erosion on the upstream slope and the erosion of the toe of the downstream slope due to wave action should be monitored, and, if the erosion in these areas continues, protective measures should be employed to protect the slopes from further damage.

7. The moles should be removed from the embankment and any and all burrowing animals should be kept off the embankment.

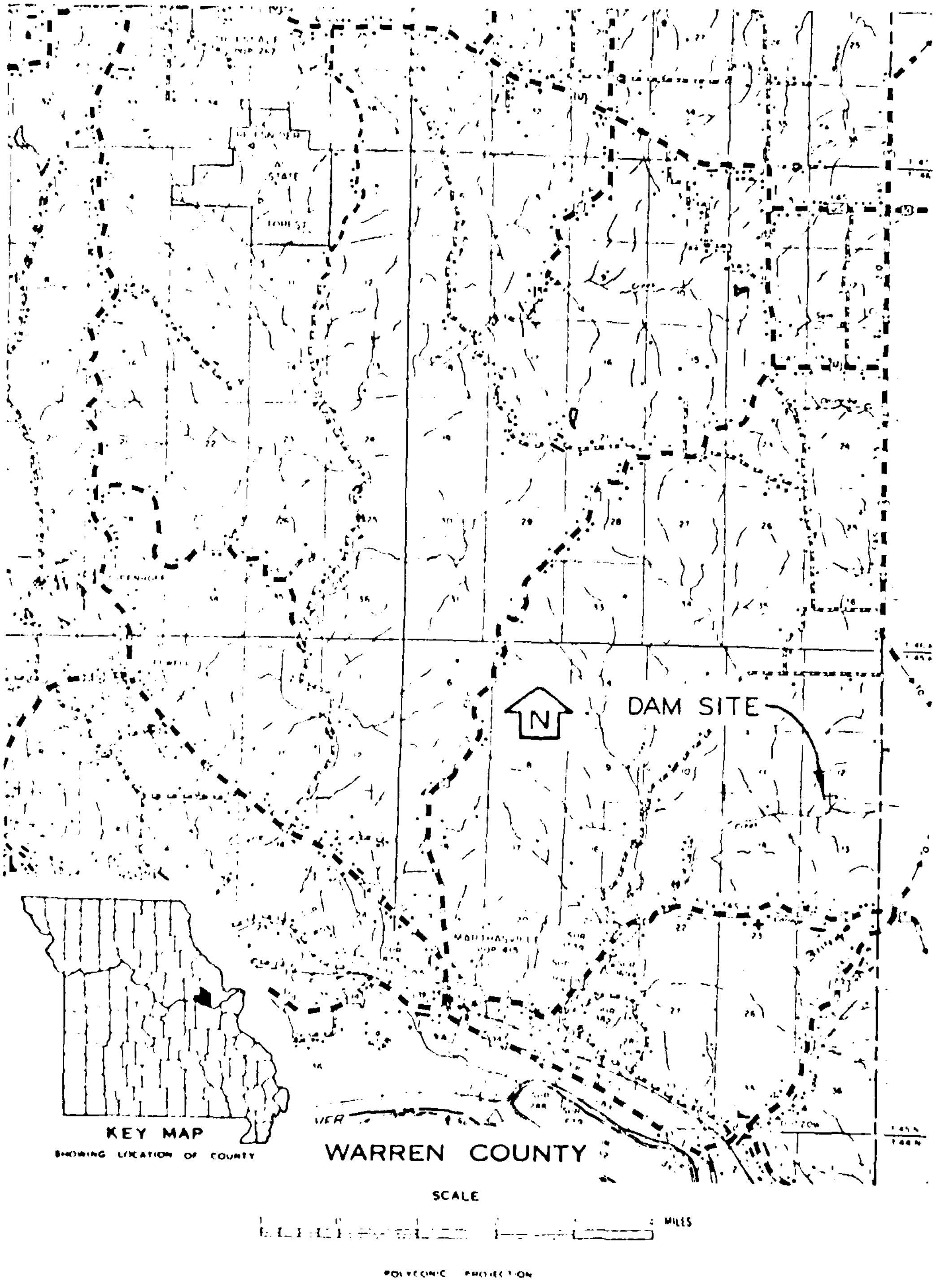
8. A well-maintained vegetative cover, especially on the downstream slope, should be sustained on the embankment to protect the surface of the dam from any erosion due to surface runoff.

9. Seepage and stability analyses should be performed by a professional engineer experienced in the design and construction of earth dams.

10. Periodic inspection of the dam by a professional engineer experienced in the design and construction of earth dams.

PLATES

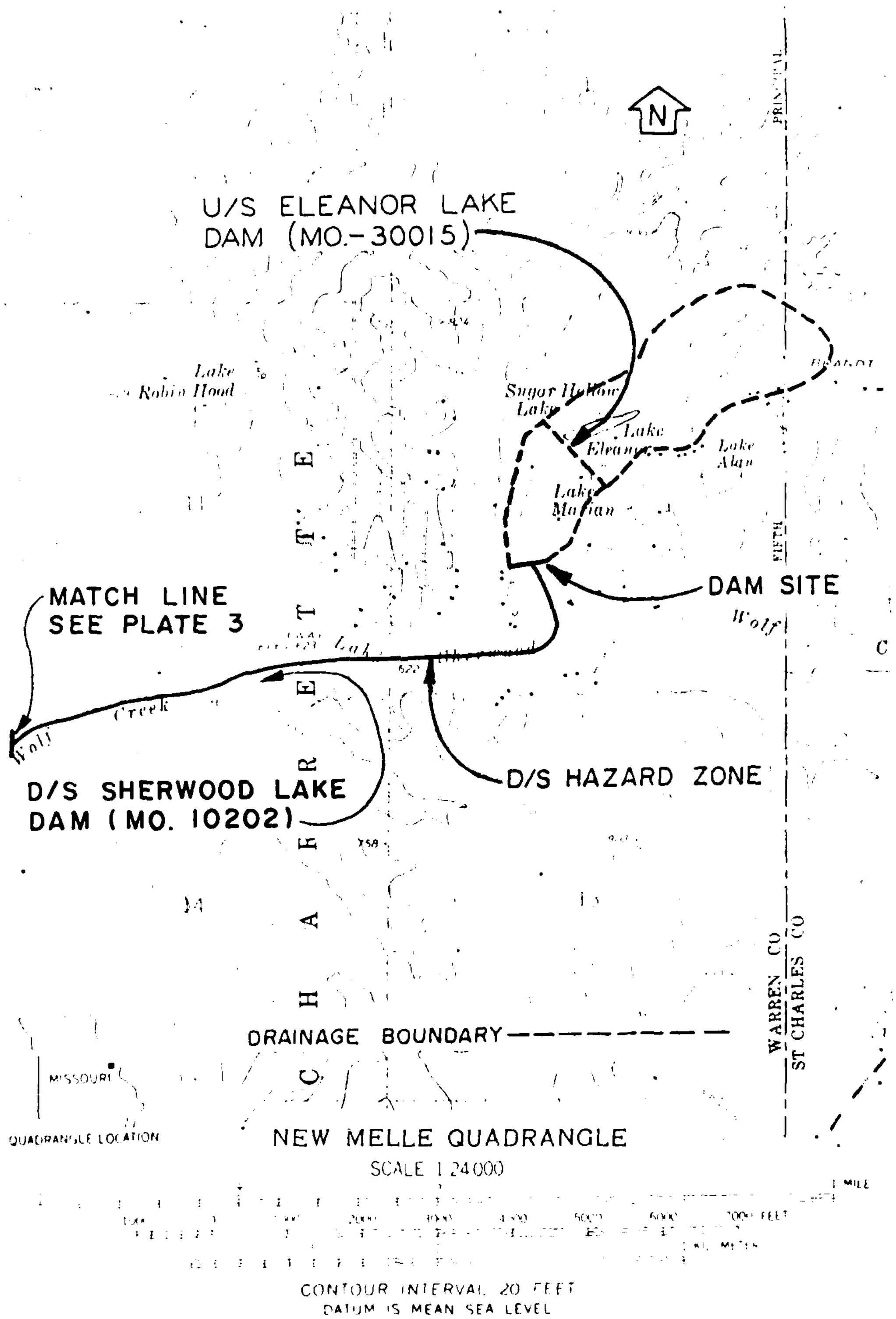
PLATE 1



LOCATION MAP - MARIAN LAKE DAM

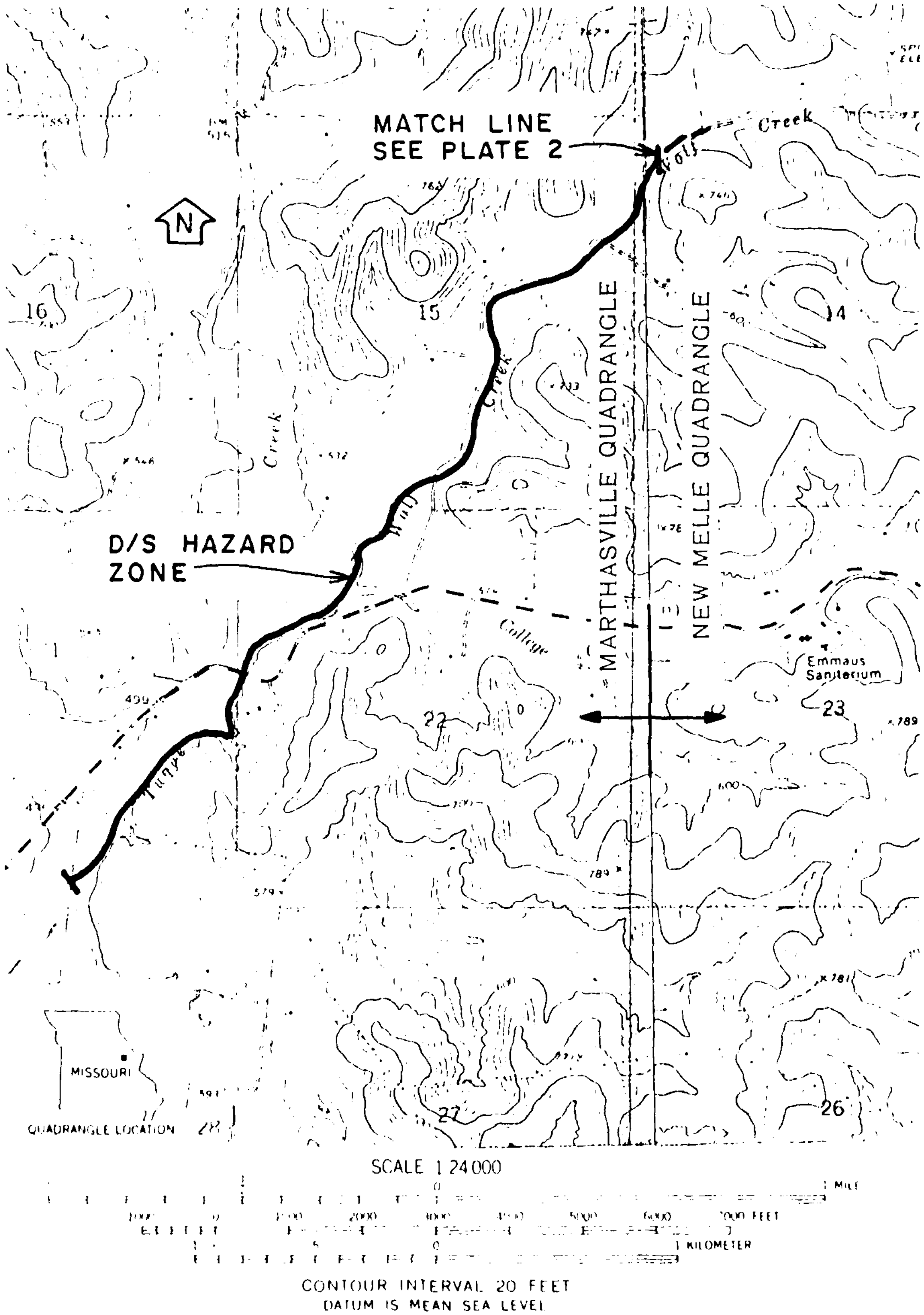
MO.-30016

PLATE 2



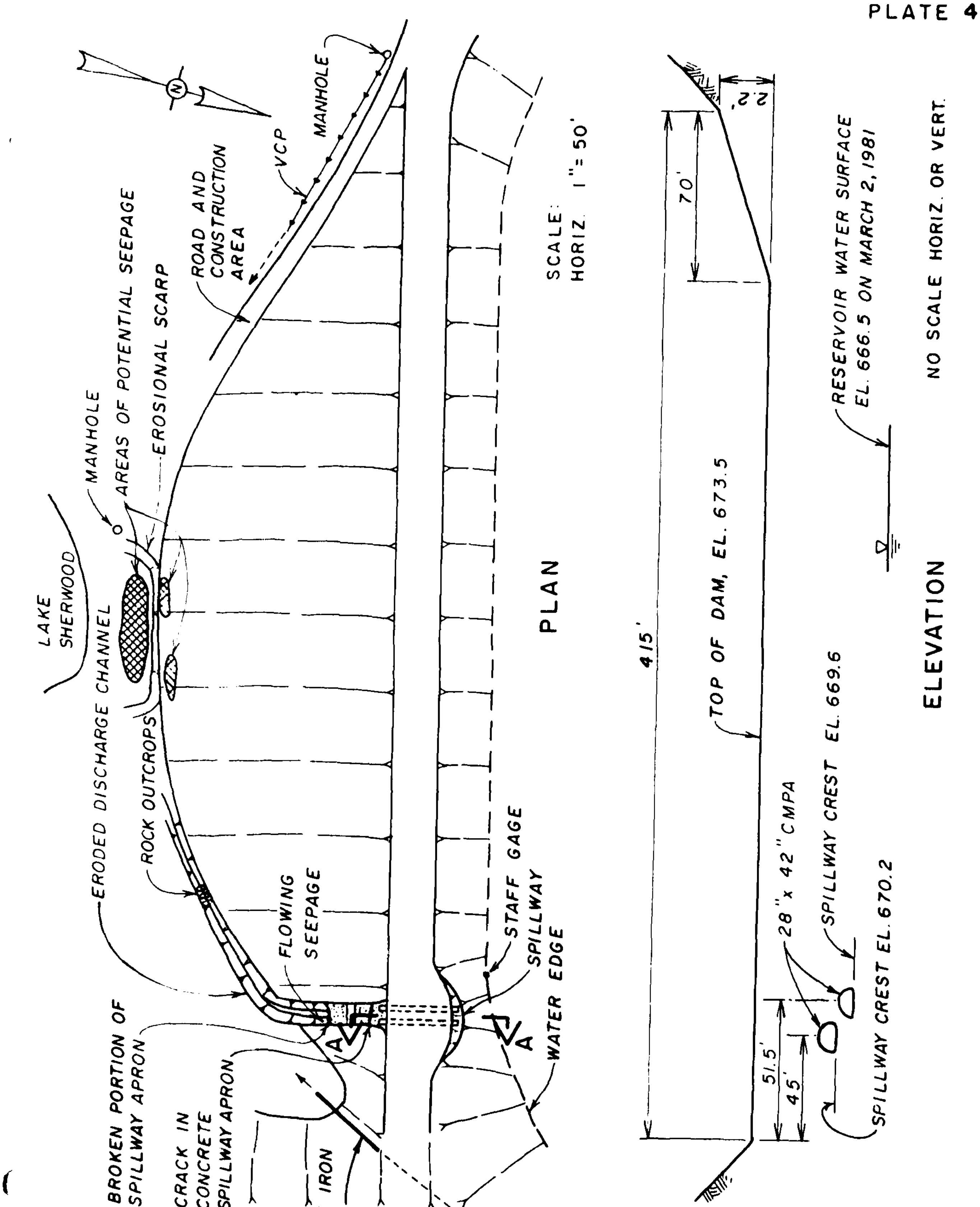
MARIAN LAKE DAM (MO.-30016)

DRAINAGE BASIN AND
DOWNSTREAM HAZARD ZONE
(SHEET 1 OF 2)

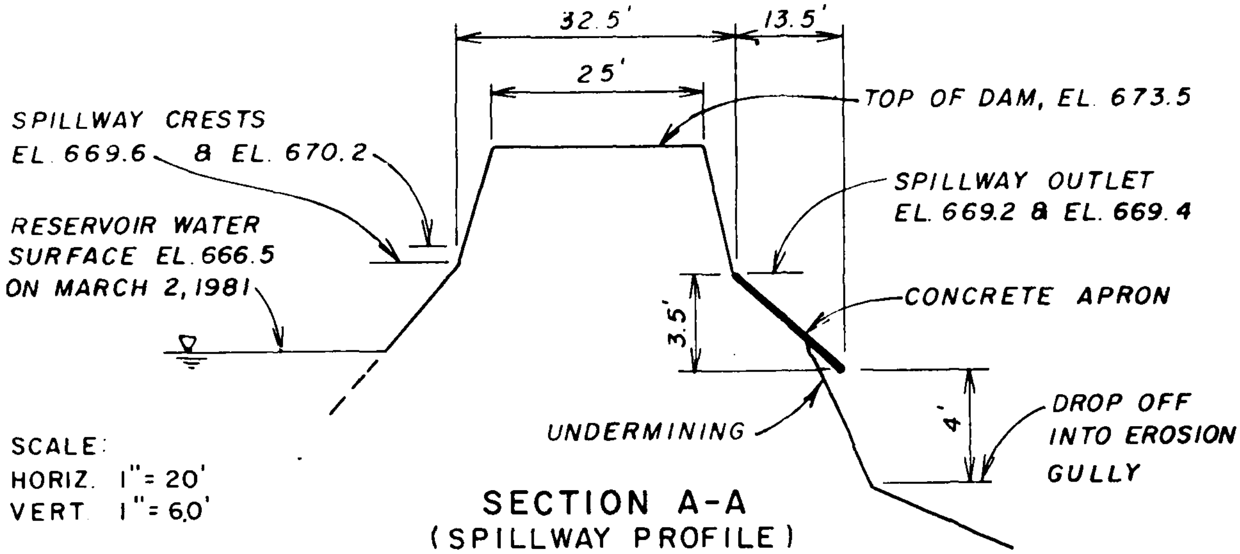


MARIAN LAKE DAM (MO.-30016)
DRAINAGE BASIN AND
DOWNSTREAM HAZARD ZONE
(SHEET 2 OF 2)

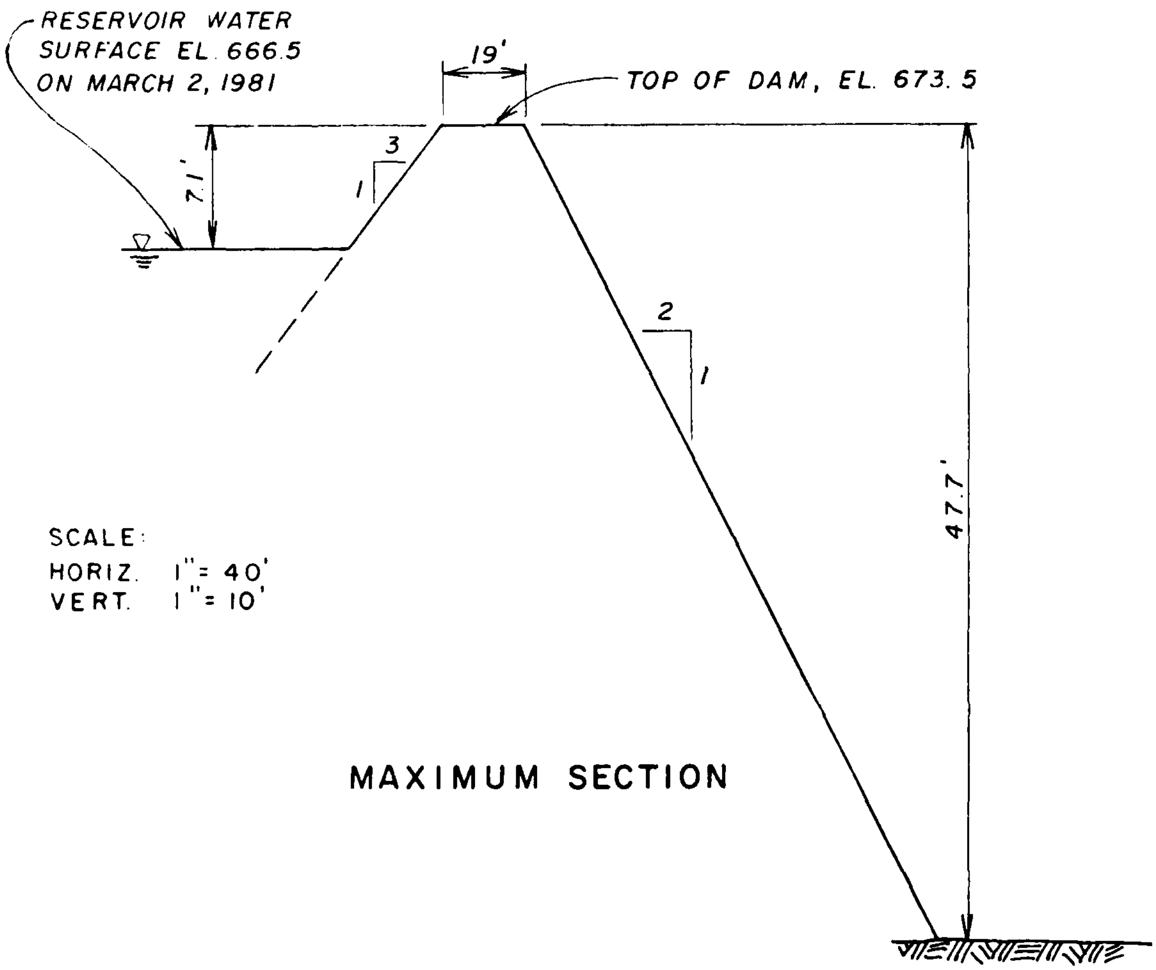
PLATE 4



MARIAN LAKE DAM (MO. 30016)
PLAN AND ELEVATION
(SHEET 1 OF 2)

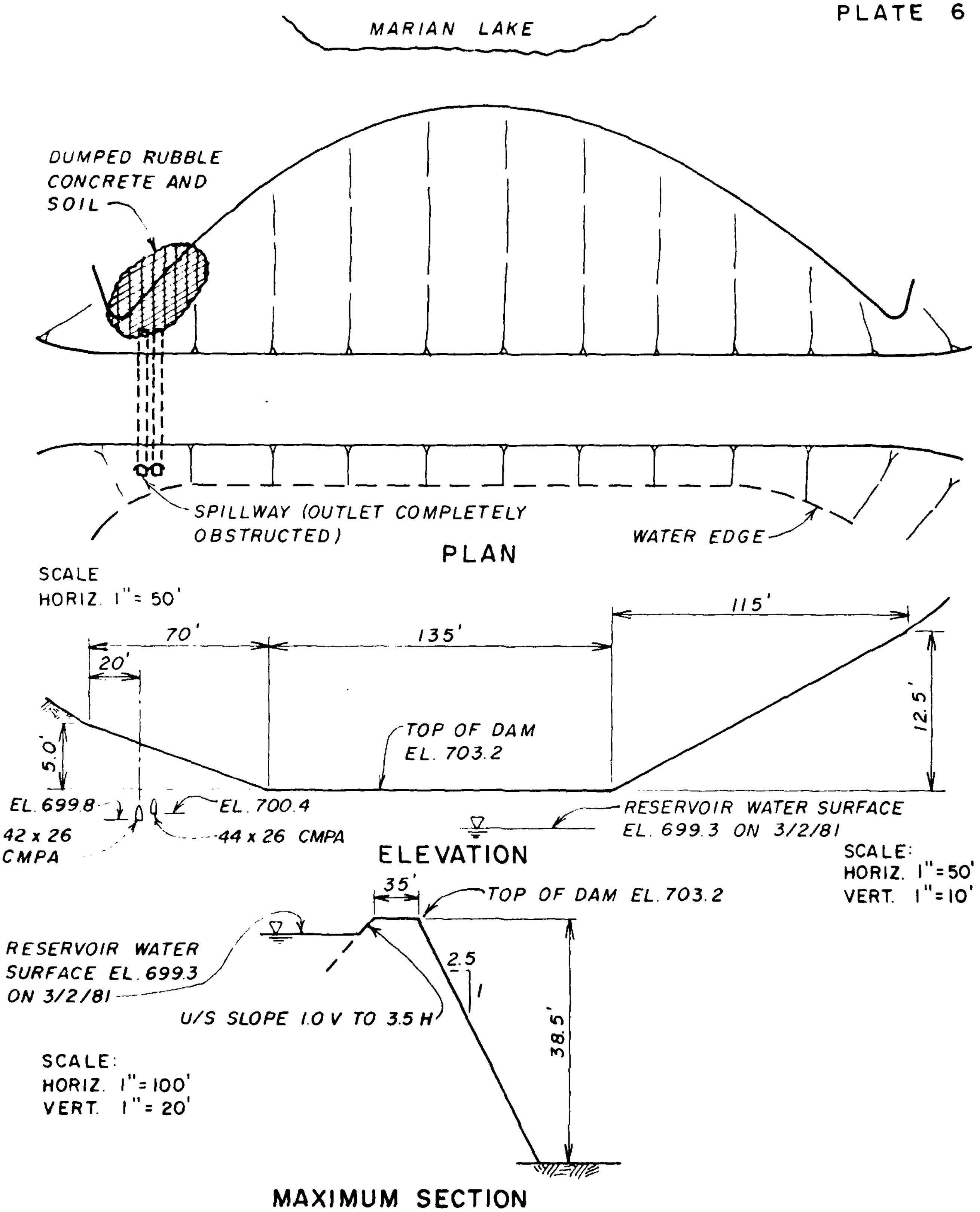


SECTION A-A
(SPILLWAY PROFILE)



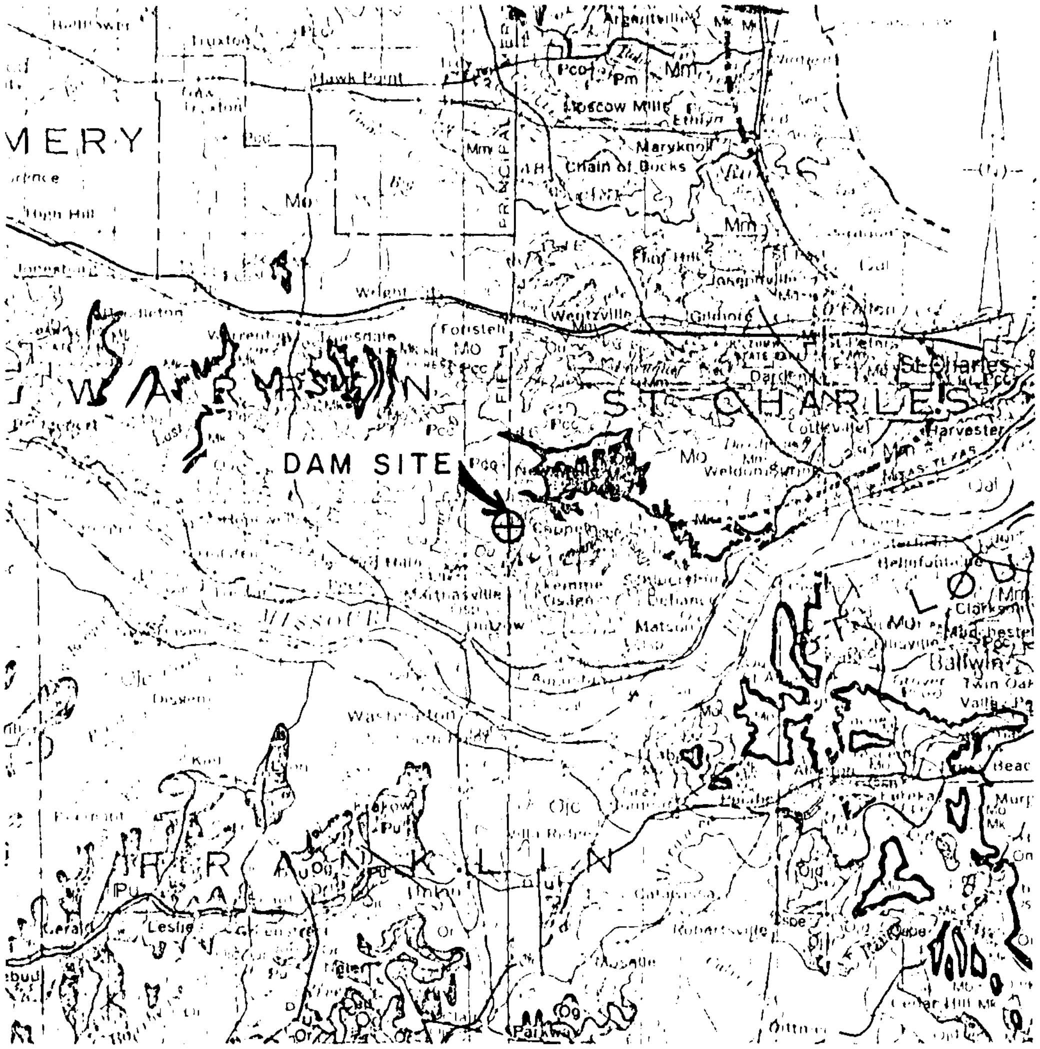
MAXIMUM SECTION

MARIAN LAKE DAM (MO. 30016)
SPILLWAY PROFILE AND
MAXIMUM SECTION OF EMBANKMENT
(SHEET 2 OF 2)

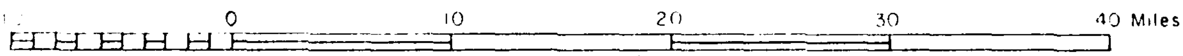


ELEANOR LAKE DAM (MO. 30015)
U/S DAM OF MARIAN LAKE
PLAN, ELEVATION AND MAXIMUM SECTION

PLATE 7



SCALE



LOCATION OF DAM

NOTE: LEGEND FOR THIS MAP IS ON PLATES 8 AND 9.

REFERENCE:

GEOLOGIC MAP OF MISSOURI
DEPARTMENT OF NATURAL RESOURCES
MISSOURI GEOLOGICAL SURVEY
KENNETH H. ANDERSON, 1979

REGIONAL GEOLOGICAL MAP
OF
MARIAN LAKE DAM

LEGEND

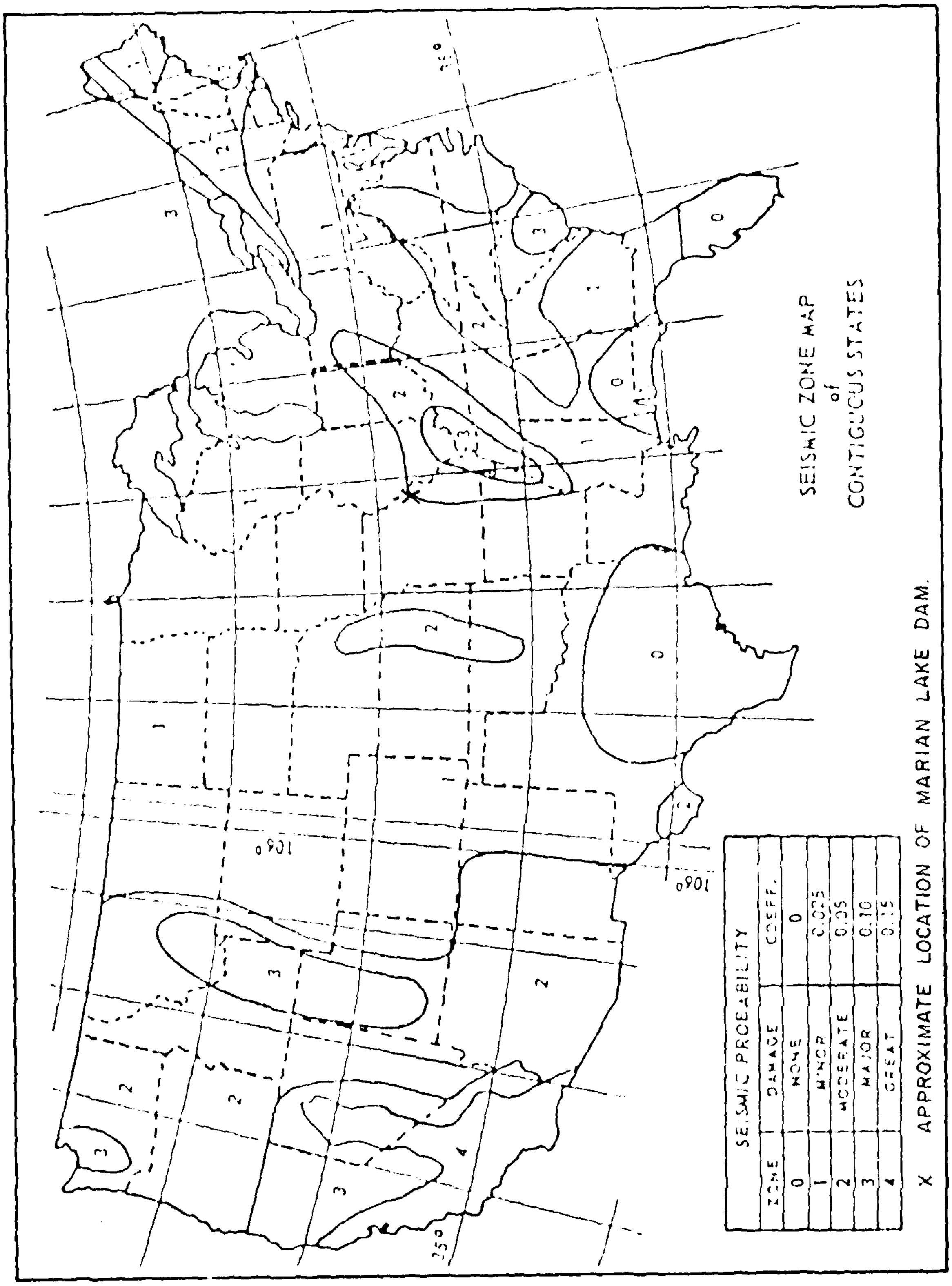
PERIOD	SYMBOL	DESCRIPTION
QUATERNARY	Qal	ALLUVIUM: SAND, SILT, GRAVEL
PENNSYLVANIAN	IPm	MARMATON GROUP: CYCLIC DEPOSITS OF SHALE, LIMESTONE AND SANDSTONE
	IPcc	CHEROKEE GROUP: CYCLIC DEPOSITS OF SHALE, LIMESTONE AND SANDSTONE
	IPu	PENNSYLVANIAN UNDIFFERENTIATED ROCKS
MISSISSIPPIAN	Mm	ST. LOUIS FORMATION: LIMESTONE INTERBEDDED WITH SHALE
	Mm	SALEM FORMATION: LIMESTONE INTERBEDDED WITH SHALE
	Mm	WARSAW FORMATION: ARGILLACEOUS LIMESTONE AND CALCAREOUS SHALE
	Mo	KEOKUK- BURLINGTON FORMATION: CHERTY GRAYISH BROWN SANDY LIMESTONE
	Mk	UNDIFFERENTIATED CHOUTEAU GROUP: LIMESTONE
	Mk	HANNIBAL FORMATION: SHALE AND SILTSTONE

MARIAN LAKE DAM
PLATE 9
SHEET 2 OF 2

LEGEND

PERIOD	SYMBOL	DESCRIPTION
	Ou	NOIX LIMESTONE
	Omk	MAQUOKETA SHALE, KIMMSWICK LIMESTON
	Odp	DECORAH FORMATION: GREEN TO GRAY CALCAREOUS SHALE WITH THIN FOSSILIFEROUS LIMESTONE
	Osp	ST. PETER SANDSTONE
ORDOVICIAN	Ospe	ST. PETER SANDSTONE, EVERTON FORMATION
	Ojd	JOACHIM DOLOMITE
	Ojc	JEFFERSON CITY DOLOMITE
	Or	ROUBIDOUX FORMATION: INTERBEDS OF CHERTY LIMESTONE AND SANDSTONE
	Og	GASCONADE DOLOMITE
	D^{U}	NORMAL FAULT
	D^{U}	INFERRED FAULT
	U =	UPTHROWN SIDE
	D =	DOWNTHROWN SIDE

PLATE 10



SEISMIC ZONE MAP
of
CONTIGUOUS STATES
SEISMIC PROBABILITY
ZONE
DAMAGE
COEFF.
0 NONE 0
1 MINOR 0.025
2 MODERATE 0.05
3 MAJOR 0.10
4 GREAT 0.15
X APPROXIMATE LOCATION OF MARIAN LAKE DAM.
106°
35°

PLATE II

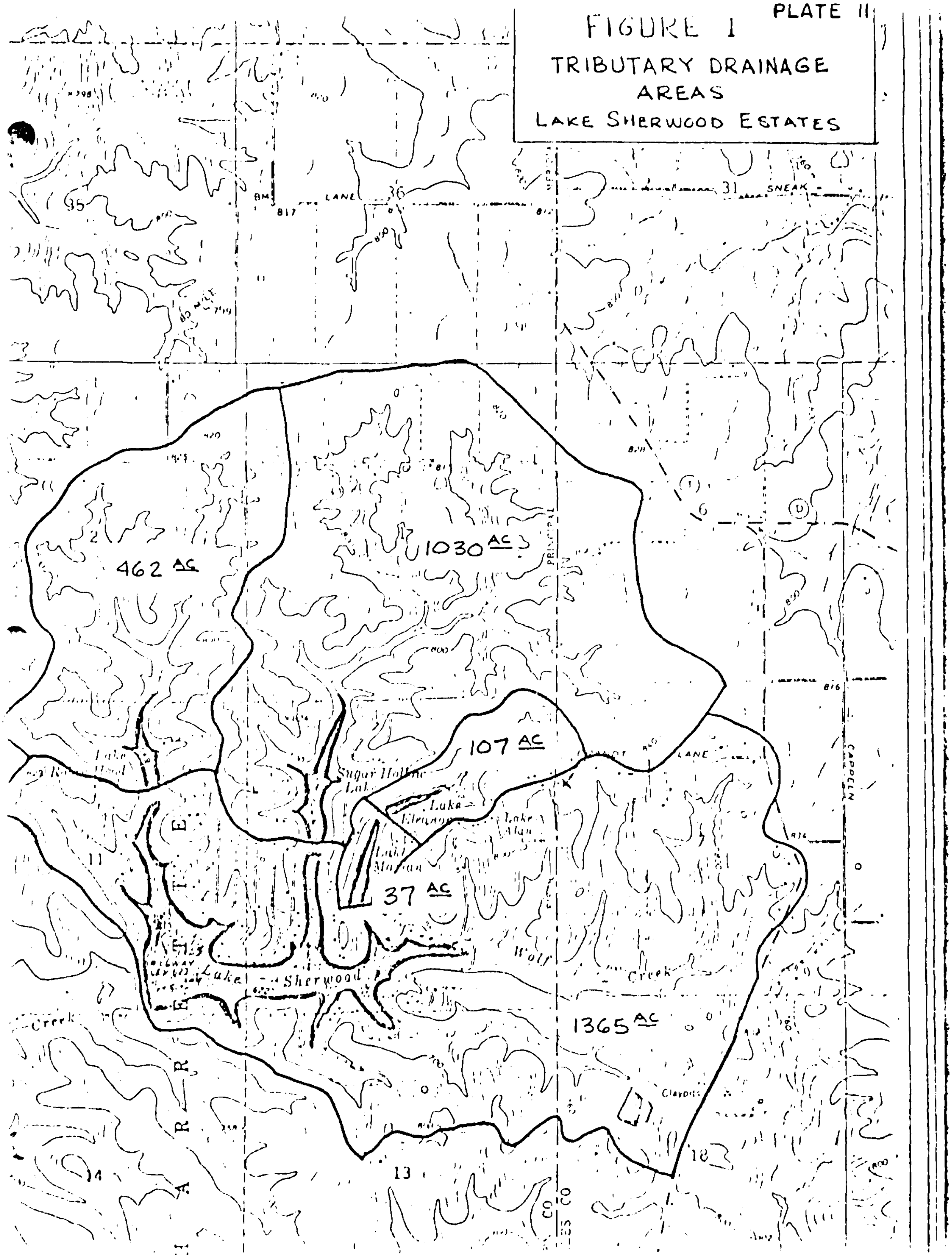


FIGURE 1
TRIBUTARY DRAINAGE
AREAS
LAKE SHERWOOD ESTATES
462 AC
1030 AC
107 AC
37 AC
1365 AC
Sugar Hollow Lake
Lake Eleanor
Lake Alan
Lake Morgan
Lake Sherwood
Wolf Creek
Creek
LANE
SNEAK
PRINCIPAL
CAPPELN
Claybolts

PLATE 12

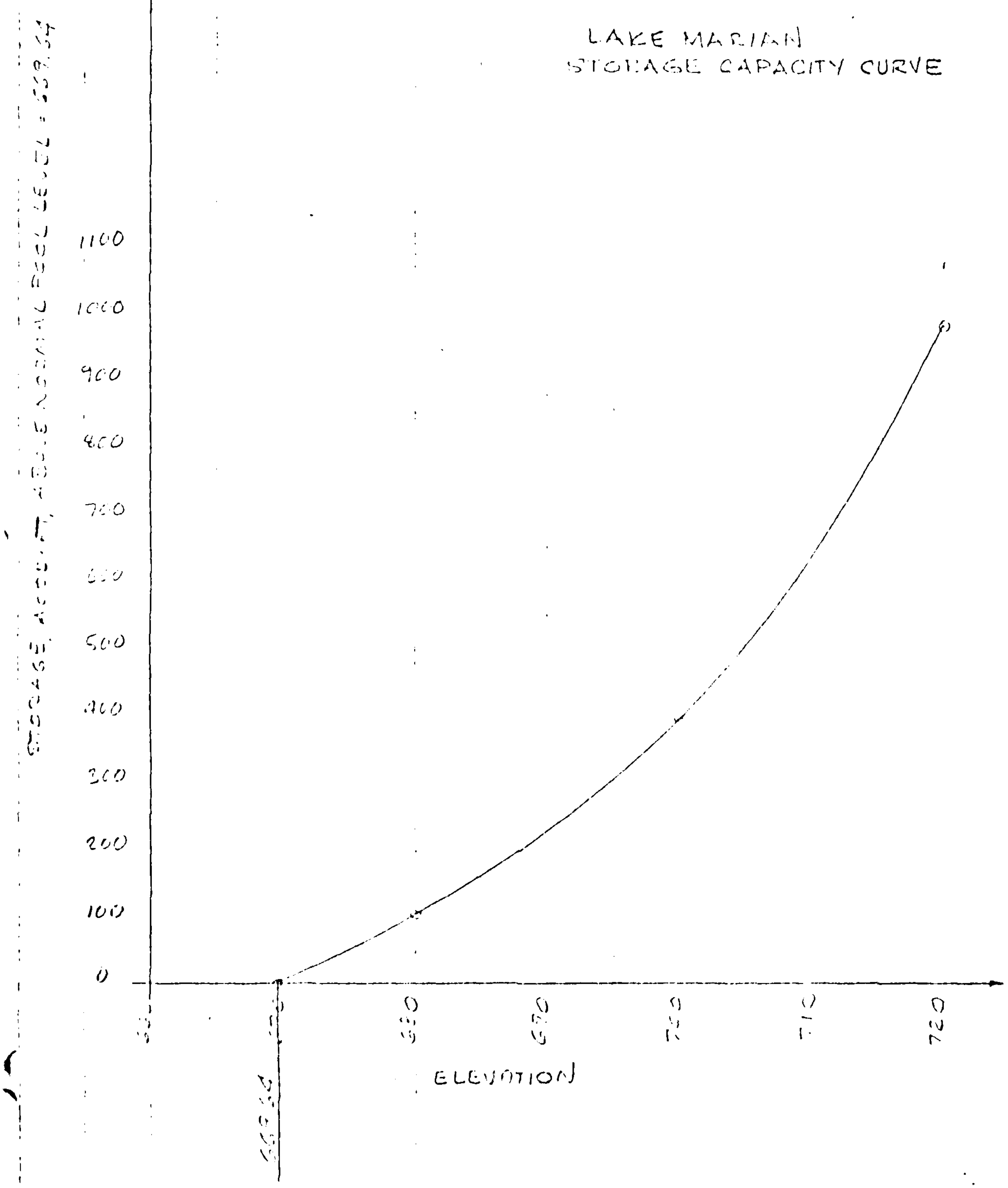
CONSULTING ENGINEERS
5200 OAKLAND AVE ST LOUIS MO 63110

SHEET NO. 20 OF 41 JOB NO. 7813
SUBJECT Sherwood Spillway
TITLE LAKE MARIAN
BY JRL DATE 11/81 CHECKED ____ DATE ____

STORAGE CAPACITY

ELEV	AREA (AC)	ΔVOLUME (AC-FT)	ΣVOLUME
668.64	6		0
		105	
680	12		105
		290	
700	17		395
		590	
720	21		985

PLATE 13


LAKE MARIAN
STORAGE CAPACITY CURVE
1100
1000
900
800
700
500
400
300
200
100
0
720
ELEVATION

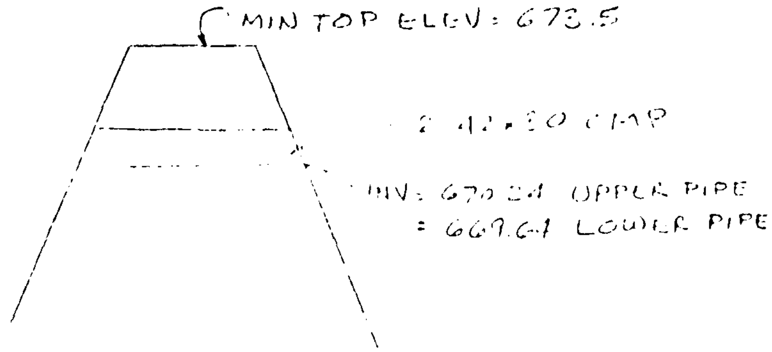
5200 OAKLAND AVE ST. LOUIS MO 63110

TITLE LAKE MARIAN

SUBJECT LAKE SHERWOOD SPILLWAY

BY JCL DATE [illegible] CHECKED ____ DATE ____

SPILLWAY ANALYSIS:



CAPACITY LAKE MARIAN SPILLWAY (1' FREE BOARD)

ASSUME INLET CONTROL.

UPPER PIPE:

EQUIVALENT PIPE ARCH

CMP 43×27 HW = 2.26'

$\frac{HW}{D} = \frac{2.26}{2.25} = 1.0$, Q = 30 CFS

LOWER PIPE:

HW = 2.86

$\frac{HW}{D} = \frac{2.86}{2.25} = 1.3$ Q_0 = 40

TOTAL Q_0 = 70 CFS

STORAGE VOLUME AVAILABLE AT 673.5 = 28 AC-FT = 1.2×10^6 FT^3

100 YR. STORM - VOLUME REQUIRED = 1.2×10^6 BALANCED

WITH INFLOW FROM LAKE ELEANOR

SEE LAKE SHERWOOD HYDROGRAPH FOR CUMULATIVE INFLOW FROM UPSTREAM LAKES

HORNER & SHIFRIN, INC.
CONSULTING ENGINEERS
5200 OAKLAND AVE   ST. LOUIS, MO 63110

PLATE 15

SHEET NO. 14 OF 21   JOB NO. 7213

SUBJECT: SHERWOOD SPILLWAY

TITLE: LAKE ELEANOR

BY: [illegible]   DATE: 2/10/78   CHECKED: ____   DATE: ____

STORAGE CAPACITY

ELEV	AREA (AC)	ΔVOLUME (AC FT)	ΣVOLUME
699.78	0		0
		121	
720	7		121
		250	
740	16		371
		380	
760	22		751

PLATE 16

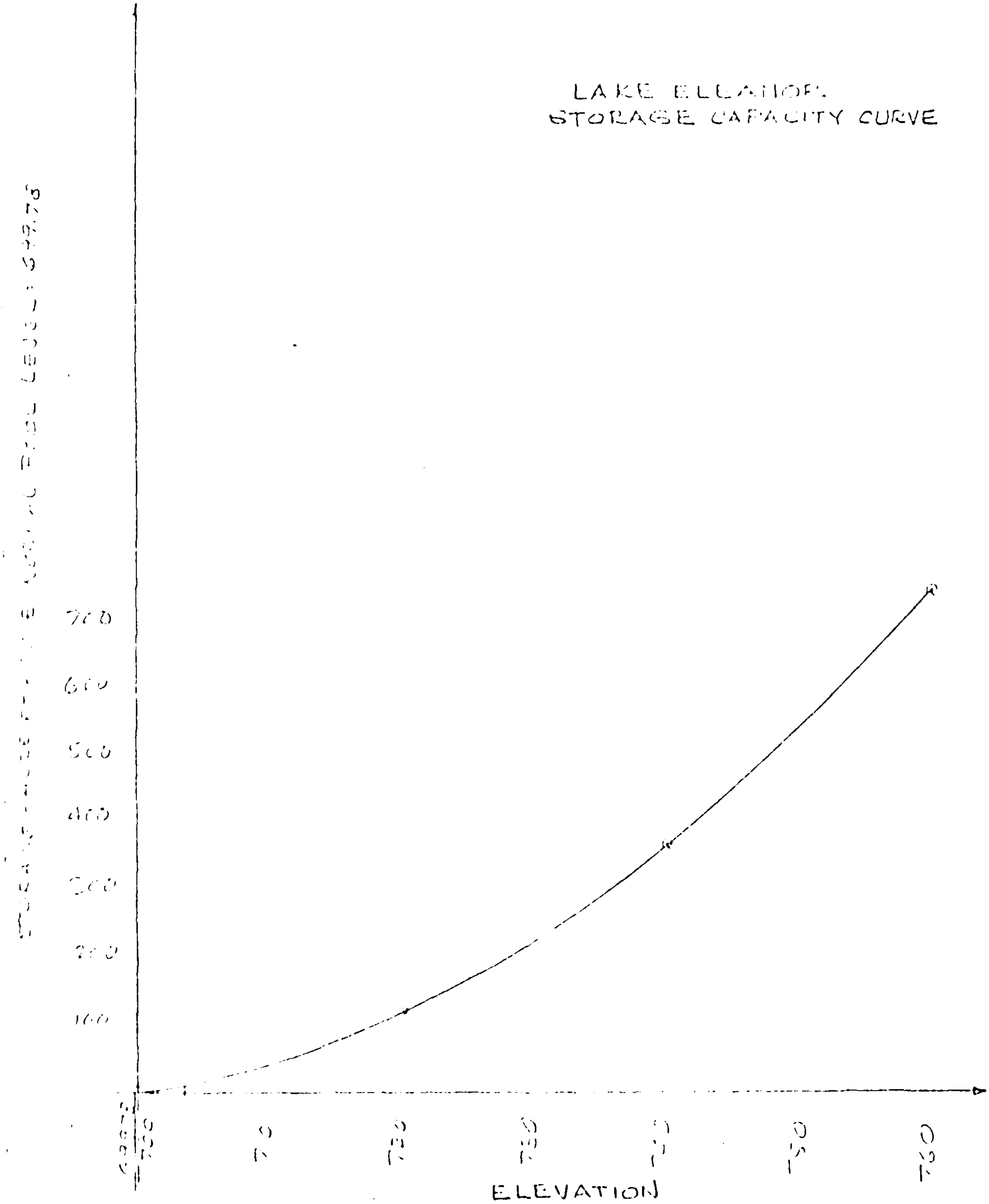

LAKE ELEANOR
STORAGE CAPACITY CURVE
700
600
500
400
300
200
100
ELEVATION

PLATE 17

HORNER & SHIFRIN, INC.
CONSULTING ENGINEERS
5200 OAKLAND AVE ST. LOUIS MO 63110

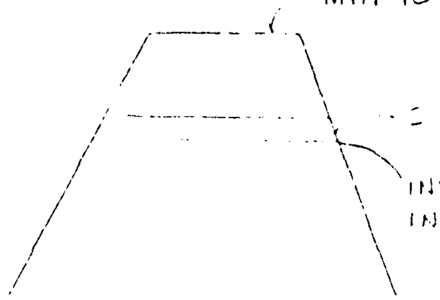
TITLE LAKE ELEANOR

SHEET NO. 16 OF 21 JOB NO. 7813

SUBJECT LAKE ELEANOR FLOOD SPILLWAY

BY JCL DATE 7/11/76 CHECKED ____ DATE ____

SPILLWAY ANALYSIS



CAPACITY LAKE ELEANOR SPILLWAY: (1' FREEBOARD)

ASSUME INLET CONTROL:

UPPER PIPE:

$HW_{MAX} = 1.8'$

$\frac{HW}{D} = \frac{1.8}{3} = .6 \quad Q_o = 15$ CFS

LOWER PIPE:

$HW_{MAX} = 2.4$

$\frac{HW}{D} = \frac{2.4}{3} = 0.8 \quad Q_o = 25$ CFS

TOTAL MAX Q_o = 40 CFS

STORAGE VOLUME AVAILABLE AT ELEV 702.2

= 5 AC-FT = 0.2×10^6 FT^3

1 YR STORM. STORAGE REQUIRED = 0.2×10^6 = BALANCED

APPENDIX A

PHOTOGRAPHS TAKEN DURING INSPECTION

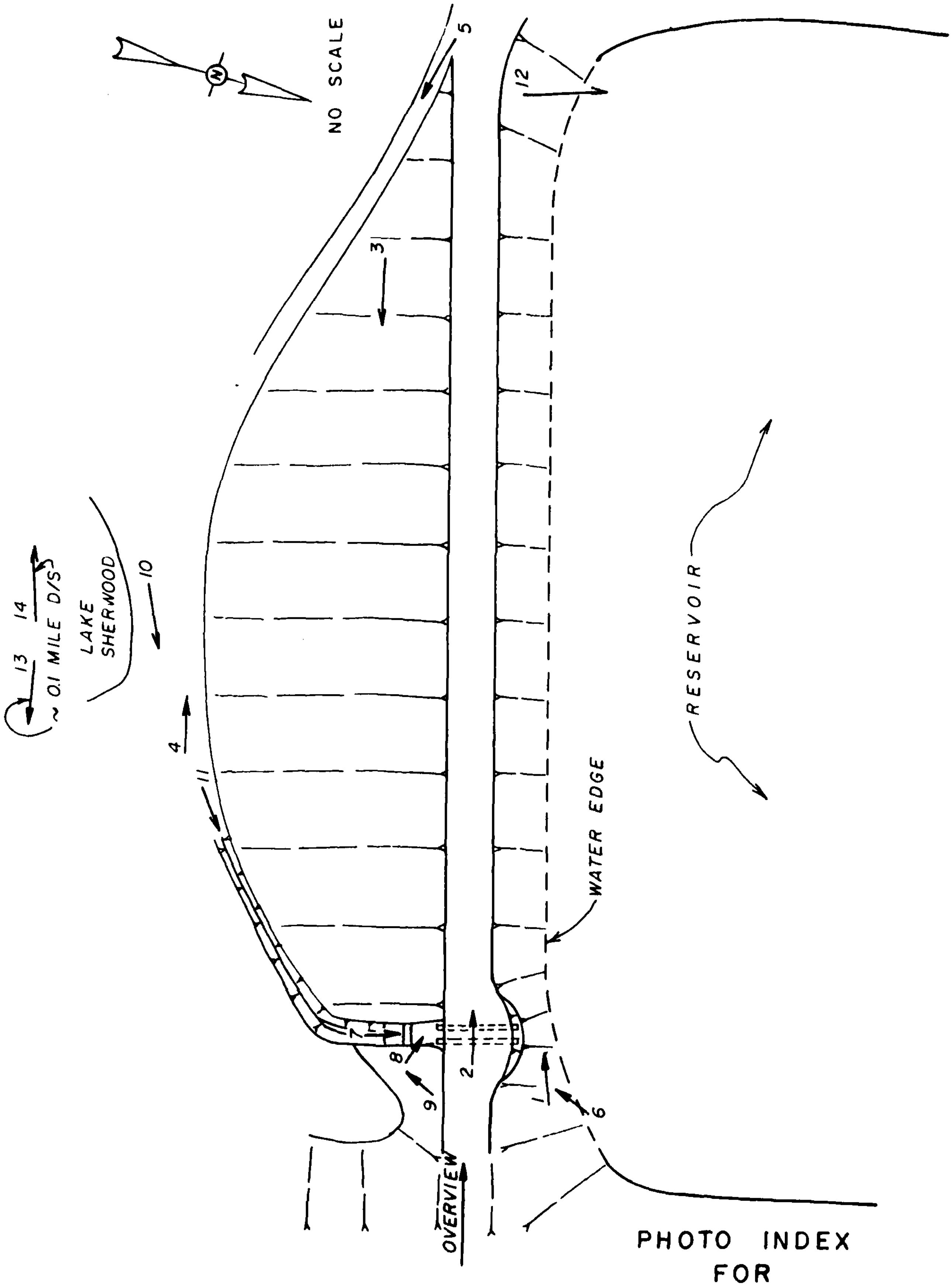


PHOTO INDEX
FOR
MARIAN LAKE DAM

Photo 1 - View of the upstream slope from the left abutment.

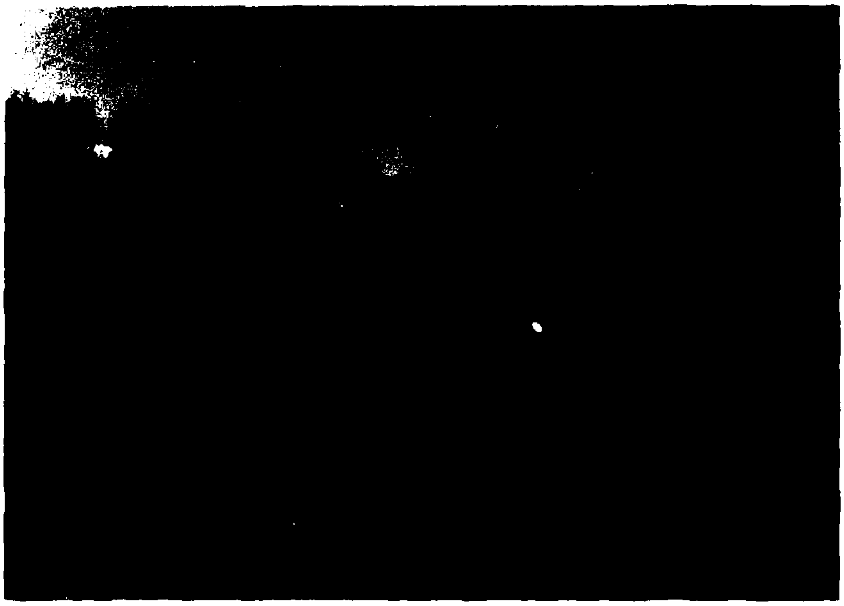


Photo 2 - View of the top of dam from the left abutment.

Photo 3 - View of the downstream slope from the right abutment.

Photo 4 - View of erosional scarp at the toe of the downstream slope.

Photo 5 - View of construction area along embankment/right abutment contact looking downstream.

Photo 6 - View of the inlet of the two corrugated metal pipe arches of the spillway.

Photo 7 - View of the outlet of the spillway. Note the collapsed portion, the undermining, and the nonreinforced concrete of the spillway apron.

Photo 8 - View of a crack in the concrete apron just downstream of the outlet of the spillway pipes.

Photo 9 - View of the eroded discharge channel of the spillway from the left abutment. Note the remaining portion of the concrete apron of the spillway in the lower right-hand corner.

Photo 10 - View of the eroded discharge channel of the spillway from the toe of the embankment.

Photo 11 - View of outcropping of sandy limestone interbedded with shale located in the discharge channel of the spillway.

Photo 12 - View of the reservoir and rim.

Photo 13 - View of the clubhouse located just downstream of the dam, which appears to be in the downstream hazard zone.

Photo 14 - View of a dwelling just downstream of the dam, which appears to be in the downstream hazard zone.

APPENDIX B

HYDROLOGIC AND HYDRAULIC COMPUTATIONS

MARIAN LAKE DAM

HYDROLOGIC AND HYDRAULIC DATA, ASSUMPTIONS AND METHODOLOGY

1. SCS Unit Hydrograph procedures and the HEC-1DB computer program are used to develop the inflow hydrographs. The hydrologic inputs are as follows:

   (a) 24-hour Probable Maximum Precipitation from the Hydrometeorological Report No. 33, and 24-hour 100-year rainfall and 24-hour 10-year rainfall of Warrenton, Missouri.

   (b) Drainage area:

      Drainage area above upstream (U/S) dam = 0.17 sq. mi.
      Drainage area between U/S dam and Marian Lake Dam = 0.06 sq. mi.

   (c) Lag time:

      Lag time for U/S dam watershed = 0.10 hr.

      Lag time for Marian Lake Dam watershed = 0.012 hr.

   (d) Hydrologic Soil Group:
   Soil Group "C" for both the U/S dam and Marian Lake Dam.

   (e) Runoff curve number:
   CN = 79 for AMC II and CN = 91 for AMC III for both the U/S dam and Marian Lake Dam.

2. The U/S Dam overtop discharge rates are based on HEC-2 generated profiles assuming critical depth at the downstream edge of the top of the dam and a Manning's n=0.03. Marian Lake spillway release rates are determined by developing culvert rating curves based on different flow regimes and determining the flow regime transition point. Flow rates over the dam are based on the broad-crested weir equation $Q = CLH^{3/2}$ and critical depth assumption.

3. Floods are routed through the upstream reservoir and then through Marian Lake to determine the capability of its spillway. This analysis included the hypothetical breach of the upstream dam for those floods during which it was overtopped. Due to the complete obstruction of the spillway of the upstream dam, Eleanor Lake Dam was overtopped and breached by every flood, including the ten-percent chance flood. The sudden release of the water stored in the upstream reservoir was a major factor in the determination of the unusually small spillway capacity for Marian Lake Dam.

ECI-4 **PRC ENGINEERING CONSULTANTS, INC.**

DAM SAFETY INSPECTION / MISSOURI — SHEET NO. ___ OF ___

DAM NAME: [illegible] LAKE DAM (MO 30016) — JOB NO. 1263

UNIT HYDROGRAPH PARAMETERS — BY TP — DATE 3/11/8

1) DRAINAGE AREA, $A = 0.06$ sq. mi = (37.0 acres)

2) LENGTH OF STREAM, $L = (0.20'' \times \frac{2000'}{1''} = 400') = 0.08$ mi.

3) ELEVATION AT DRAINAGE DIVIDE ALONG THE LONGEST STREAM,

$H_1 = 765$

4) ELEVATION OF RESERVOIR AT SPILLWAY CREST, $H_2 = 662.6$

5) ELEVATION OF CHANNEL BED AT 0.85L, $E_{85} = 750$

6) ELEVATION OF CHANNEL BED AT 0.10L, $E_{10} = 680$

7) AVERAGE SLOPE OF THE CHANNEL, $S_{AVG} = (E_{85} - E_{10}) / 0.75L = 0.23$

8) TIME OF CONCENTRATION:

A) BY KIRPICH'S EQUATION,

$$t_c = [(11.9 \times L^3)/(H_1 - H_2)]^{0.385} = \left[(11.9)(0.08)^3\right] / (765 - 669.6)\Big]^{0.385}$$

$t_c = 0.02$

B) BY VELOCITY ESTIMATE,

SLOPE = 23% ⟹ AVG. VELOCITY = 5 ft/sec.

$t_c = L/V = 400/5 \text{ ft/sec} = 0.02$ hours

USE $t_c = 0.02$

9) LAG TIME, $t_l = 0.6\, t_c = 0.012$

10) UNIT DURATION, $D \le t_l / 3 = 0.004$ < 0.083 hr.

USE $D = 0.083$ hours

11) TIME TO PEAK, $T_P = D/2 + t_l = 0.054$ hours

12) PEAK DISCHARGE,

$$q_P = (484 \times A) / T_P = (484 * 0.06\ mi^2) / 0.054 = 540 \text{ cfs}$$

DAM SAFETY INSPECTION - MISSOURI
DAM NAME: MARIAN LAKE Dam (MO. 30016)
RESERVOIR ELEVATION - CAPACITY DATA

1283
3/11/8

ELEVATION (NGVD)	RESERVOIR CAPACITY (acre-ft)	REMARKS
640	0	Estimated Streambed at Dam
650	15	Interpolated
660	52.5	Interpolated
669.6	18.5	Spillway Crest *
673.5	147.0	Top of Dam
680	223.5	Area Measured on U.S.G.S. Quad *
690	326.0	Interpolated
700	513.5	Area measured on USGS Quad *

* Incremental capacity values at these points taken from Horner and Shifrin report, areas reported verified on U.S.G.S. Quad (see Plate 12)

ECI-4 **PRC ENGINEERING CONSULTANTS, INC.**

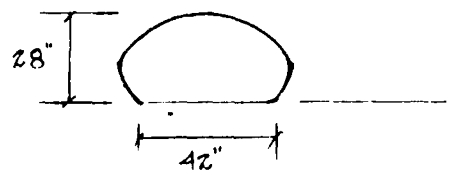
L. AM SAFETY — SHEET NO. 1 OF ___

MACIAN LAKE DAM — JOB NO. ___

ARCH PIPE RATING CURVES — BY TP — DATE 3/16

INLET CONTROL RATING CURVES {CULVERT # 1}

UPSTREAM FACE



El. 669.6 [— EL. 670.2 For OTHER 42"x28"x32.5' CULVERT]

ARCH PIPE, 42" x 28" x 32.5'

ASSUME CRITICAL DEPTH @ INLET, BEFORE PRESSURE FLOW

(NOTE: Fig. 4-26 pg. 170 and Fig 4-40 pg. 185 (for a 43"x27" pipe arch) of "Handbook of Steel Drainage & Highway Construction Products" by AISI was used for determining inlet control rating curve)

TOTAL CROSS-SECTIONAL AREA OF PIPE:

$A_T = 6.4\ ft^2$

	Y (ft)	A (ft²)	Q (cfs)	V (ft/sec)	V²/2g (ft)	WSEL (NGVD)
	0.7	1.86	10.0	5.40	0.453	670.75
	0.8	2.24	13.0	5.80	0.522	670.92
	1.0	2.94	18.5	6.40	0.64	671.24
	1.3	4.16	29.0	6.97	0.75	671.65
	1.6	4.99	41.0	8.2	1.04	672.24
*	1.75	5.44	49.0	9.0	1.26	672.61
	1.90	5.76	62.04	10.77	1.80	673.30
	2.0	5.95	67.56	11.35	2.00	673.60
	2.1	6.08	76.24	12.54	2.44	674.14
	2.2	6.21	82.0	13.2	3.08	674.88
	2.3	6.40	93.0	14.53	3.36	675.26

* Elevation @ which transition from open channel flow to full pipe flow occurs

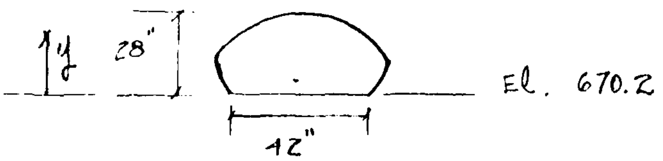
PRC ENGINEERING CONSULTANTS, INC.

Dam Safety — SHEET NO. ____ OF ____

Marian Lake Dam — JOB NO. ____

Arch-Pipe rating curve — BY TP — DATE 3/17/

INLET CONTROL CURVE {CULVERT #2}



Arch Pipe, 42" x 28" x 32.5'

Total cross-sectional area of pipe = 6.4 ft^2

y (ft)	A (ft^2)	Q (cfs)	V (ft/sec)	$V^2/2g$ (ft)	WSEL (MSL)
0.10	0.19	1.04	5.4	0.453	670.75
0.20	0.38	2.23	5.8	0.522	670.92
0.40	0.90	5.73	6.4	0.64	671.24
0.70	1.86	12.94	6.97	0.75	671.65
1.00	2.94	24.11	8.2	1.04	672.24
1.15	3.52	31.68	9.0	1.26	672.61
1.30	4.16	44.51	10.77	1.80	673.3
1.4	4.48	50.85	11.35	2.00	673.6
1.5	4.74	59.39	12.54	2.44	674.14
* 1.6	4.99	65.87	13.2	3.08	674.88
1.7	5.38	78.11	14.52	3.36	675.26

* Elevation @ which transition from open flow to full pipe flow occurs.

OUTLET CONTROL RATING (PRESSURE FLOW)

By the continuity law

$$Q = VA$$

by Torricelli's law
ideal velocity, $V_i = \sqrt{2gH_T}$

considering entrance, exit and friction head losses.

$$V = \sqrt{\frac{2gH_T}{\Sigma K}}$$

where $\Sigma K = K_{ent} + K_{exit} + K_f$

$K_{ent} = 0.5$

$K_{exit} = 1.0$

$K_f = \dfrac{29.16\, n^2 l}{R^{4/3}}$

$l = 32.5'$
$n = 0.025$
$R = \dfrac{A}{P} = \dfrac{6.4}{\pi(\frac{36}{12})} = 0.68$

$$K_f = \frac{(29.16)(0.026)^2(32.5)}{(0.68)^{4/3}} = 1.10$$

$$\Sigma K = 0.5 + 1.0 + 1.10 = 2.6$$

$$\boxed{\therefore V = 4.98\sqrt{H_T}} \longrightarrow Q = 6.4(4.98)\sqrt{H_T}$$

$$Q = 31.87\sqrt{H_T}$$

PRC ENGINEERING CONSULTANTS, INC.

[illegible] Safety	SHEET NO. 3	OF
[illegible]	JOB NO. –	
[illegible] RATING CURVES	BY [illegible]	DATE 3/16/81

[illegible] DATUM @ $\left(\frac{RISE}{2}\right)$ [illegible] INVERT

DATUM = 669.2 + 1.17' = 670.37 (NGVD)

CULVERT #1

[illegible] (NGVD)	H_T (ft)	Q (cfs)
667.60	0.0	0.
670.70	0.33	17.30
671.03	0.66	25.89
671.73	1.56	39.81
672.0	1.63	40.69
672.3	1.73	44.28
672.6	2.23	47.60
[illegible]	2.53	50.7
673.0	2.63	51.69
673.2	2.73	54.56
[illegible]	3.23	57.28
674.14	3.77	61.88
674.6	4.23	65.56
675.6	5.23	72.29
676.6	6.23	77.55
677.6	7.23	83.70
678.6	8.23	91.43
679.0	8.63	98.91

PRC ENGINEERING CONSULTANTS, INC.

DAM SAFETY — SHEET NO. 4 OF ____
MARIAN LAKE DAM — JOB NO. ____
[illegible] RATING CURVES — BY JT — DATE 3/16/8[illegible]

(1) CULVERT #2

DATUM = 669.4 + 1.17 = 670.57

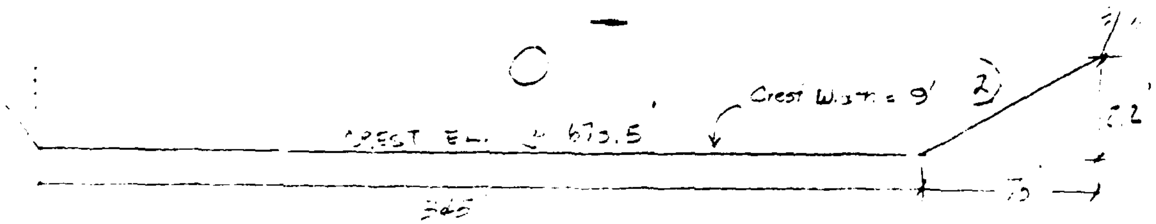
RESERVOIR W.EL (NGVD)	H_T (ft)	Q (cfs)
[illegible]	0	0.
670.7	0.13	11.49
671.93	[illegible]	37.17
672.0	1.43	38.11
672.3	1.73	41.92
672.6	2.03	45.41
672.9	2.33	48.65
673.0	2.43	49.68
[illegible]	2.73	52.66
673.6	3.03	55.48
674.14	3.57	60.22
674.6	4.03	63.98
675.6	5.03	71.48
676.6	6.03	78.27
677.6	7.03	84.51
678.6	8.03	90.32
679.0	9.43	97.27

PRC ENGINEERING CONSULTANTS, INC.

Dam Safety Inspection — SHEET NO. 6 OF

Harian Lake Dam — JOB NO. 1283

Overtop Rating Curve — BY TP DATE 3/13/81



[illegible]	H_1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
[illegible]	0.	0.	0.	[illegible]	0.	0.	0.	0.
[illegible]	0.1	3.12	31.16	0.08	0.65	0.1	1.12	0.12
[illegible]	0.64	3.05	535.22	0.51	10.29	4.17	2.87	11.97
[illegible]	1.10	3.035	1208.0	0.88	28.00	12.32	3.70	46.37
[illegible]	2.10	3.045	3196.14	[illegible]	53.45	44.70	5.20	232.52
[illegible]	3.10	3.058	5758.37	[illegible]	70.00	93.33	6.55	611.55
[illegible]	4.10	3.081	8824.43	3.10	70.00	140.00	8.12	1123.41
[illegible]	5.10	3.01	12779.13	3.77	70.00	180.07	[illegible]	1729.73
[illegible]	6.60	3.09	17,666.39	4.70	70.00	252.00	10.77	2713.[illegible]

Section (1) for all depths "y" $\Rightarrow Q = CLH^{3/2}$

Section (2) for $0 \le y \le 2.2 \Rightarrow Q = CLH^{3/2}$, $y_c = 4/5\,H$

$T = 31.82\,y_c$, $A = \frac{Ty}{2} = \frac{31.82\,y_c^2}{2}$

for $y > 2.2 \Rightarrow y_2 = 2/3\left(H_1 + \frac{2.2}{4}\right)$, $A = 70\left(y_2 - \frac{2.2}{2}\right)$

$T = 70$

BRO ENGINEERING CONSULTANTS

Dam Safety | Sheet No. 1 of

Marian Lake Dam | Job No.

Combined Rating | By TP | Date 3/17

Reservoir Elev. (NGVD)	Culvert #1 Discharge (cfs)	Culvert #2 Discharge (cfs)	Dam Overtop Discharge (cfs)	Combined Discharge (cfs)
699.6				0
670.75	10.0	1.04	0.	11
670.92	13.0	2.23	0.	15
671.24	18.5	5.73	0.	24
671.65	29.0	12.94	0.	42
672.24	41.0	24.11	0.	65
672.61	47.6	31.68	0.	79
673.3	54.56	44.51	0.	99
673.6	57.28	50.85	32.08	140.
[illegible]	61.88	[illegible]	547.19	668
674.6	65.55	63.98	1254.37	1384
675.6	72.89	71.48	3430.46	3574
676.6	79.55	78.27	6369.92	6528
677.6	85.70	84.51	9947.92	10118
678.6	91.43	90.32	14007.91	14190
680.0	98.91	97.87	20379.57	20576

PRC ENGINEERING CONSULTANTS, INC.

DAM SAFETY INSPECTION / MISSOURI — SHEET NO. ___ OF ___

DAM NAME: Eleanor Lake Dam (MO. 30015) — JOB NO. 1263

UNIT HYDROGRAPH PARAMETERS — BY TP — DATE ___

1) DRAINAGE AREA, $A = 0.17$ sq. mi. = (107 acres)

2) LENGTH OF STREAM, $L = (1.25'' \times 2000'/'' = 2500') = 0.47$ mi.

3) ELEVATION AT DRAINAGE DIVIDE ALONG THE LONGEST STREAM,

$H_1 = 825$

4) ELEVATION OF RESERVOIR AT SPILLWAY CREST, $H_2 = 703.2$

5) ELEVATION OF CHANNEL BED AT 0.85L, $E_{85} = 780$

6) ELEVATION OF CHANNEL BED AT 0.10L, $E_{10} = 720$

7) AVERAGE SLOPE OF THE CHANNEL, $S_{AVG} = (E_{85} - E_{10})/0.75L = 0.03$

8) TIME OF CONCENTRATION:

A) BY KIRPICH'S EQUATION,

$t_c = [(11.9 \times L^3)/(H_1 - H_2)]^{0.385} = 0.17$ hours

B) BY VELOCITY ESTIMATE,

SLOPE = 3% ⟹ AVG. VELOCITY = 3 ft/sec.

$t_c = L/V = 2500/3'/sec = 0.23$ hours

USE $t_c = 0.17$ hours

9) LAG TIME, $t_\ell = 0.6\, t_c = 0.10$ hours

10) UNIT DURATION, $D \le t_\ell / 3 = 0.03$ hr. < 0.083 hr.

USE $D = 0.083$ hr.

11) TIME TO PEAK, $T_p = D/2 + t_\ell = 0.14$ hr.

12) PEAK DISCHARGE,

$q_p = (484 \times A)/T_p = \frac{[illegible]}{0.14} = 590$ [illegible]

DAM SAFETY INSPECTION - MISSOURI
DAM NAME: ELEANOR LAKE Dam (MO. 30015)
RESERVOIR ELEVATION - CAPACITY DATA

TP 3/18/...

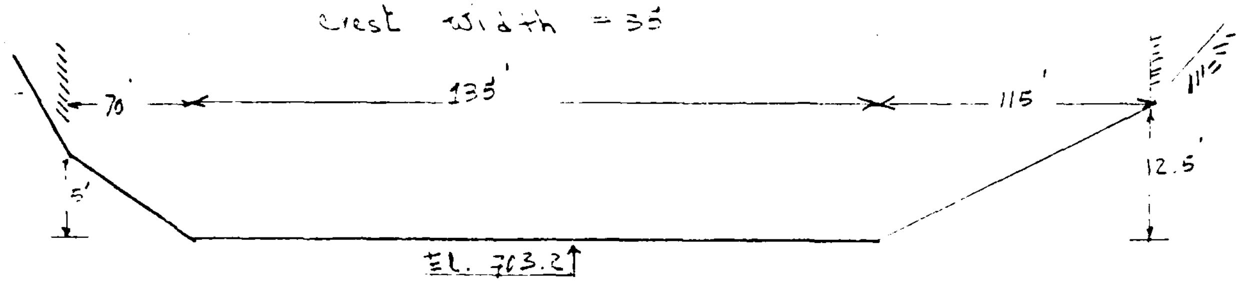
ELEVATION (NGVD)	RESERVOIR CAPACITY (acre-ft)	REMARKS
680	0	Estimated streambed @ Dam
690	11.0	Interpolated
699.8	29.5	Spillway crest (culverts blocked) *
703.2	48.0	Top of Dam
710	90.0	Interpolated
720	150.5	Area measured on U.S.G.S. Quad *
730	272.0	Interpolated
740	400.5	Area measured on USGS Quad *
750	510.0	Interpolated
760	730.5	Area measured on USGS Quad *

* Incremental capacity values at these points taken from Horner and Shifrin report, areas reported verified on U.S.G.S. Quad (see Plate 5)

PRC ENGINEERING CONSULTANTS, INC.

Dam Safety Inspection
Eleanor Lake Dam
Dam overtop rating curve.

SHEET NO. ____ OF ____
JOB NO. 1263
BY JP DATE 3/11/[illegible]



For $y_c \le 5'$ $A = y_c\left(y_c\left(\frac{70}{5} + \frac{115}{12.5}\right) - 135\right)$, $T = y_c\left(\frac{\frac{70}{5} - \frac{115}{12.5}}{2}\right) - 35$

For $5 < y_c < 12.5'$ $A = \left[y_c\left(135 + 70 + \frac{115 y_c}{(2)(12.5)}\right) - \frac{70(5)}{2}\right]$, $T = 135 + 70 + \frac{115 y_c}{12.5}$

For $y_c \ge 12.5'$ $A = y_c(T) - \left[\frac{(115)(12.5) + 70(5)}{2}\right]$, $T = 135 + 70 + 115$

REFER TO HEC-2 PRINTOUT

Y_c	T_c	A_c	V_c	Q	Y_1	V_1	$V_1^2/2g$	WSEL
0	0	0	0	0	0	0	0	703.20
0.14	38.32	18.96	2	10	0.33	0.88	0.012	703.54
0.16	138.73	22.00	2.27	50	[illegible]	0.97	0.015	703.58
0.26	140.73	35.24	2.84	100	0.51	1.37	0.030	703.74
0.40	144.33	56.18	3.56	200	0.72	1.92	0.057	703.98
0.53	147.18	74.01	4.05	300	0.87	2.33	0.084	704.18
0.63	149.71	90.77	4.43	400	1.04	2.64	0.108	704.24
0.73	152.04	105.43	4.74	500	1.16	2.90	0.131	704.49
0.96	157.23	137.91	5.36	750	1.42	3.44	0.184	704.82
1.15	161.76	171.12	5.84	1000	1.67	3.87	0.235	705.10
1.50	161.72	228.02	6.58	1500	2.07	4.56	0.323	705.59
1.77	176.56	279.03	7.17	2000	2.41	5.08	0.401	706.01
2.06	182.79	[illegible]	7.64	2500	2.71	[illegible]	0.477	706.39
2.31	182.55	373.[illegible]	8.03	3000	2.97	5.72	0.544	706.73
2.77	191.23	402.62	9.65	4000	3.48	[illegible]	0.666	707.[illegible]

HEC-2 INPUT AND SUMMARY TABLE

```
[illegible]/03/17.   14.1[illegible].47.                                                                          PAGE  1

*****************************************************
 HEC1 RELEASE DATED NOV 76 UPDATED [illegible]
 ERROR CORR - [illegible]
 MODIFICATION - [illegible]
*****************************************************

T1        MISSOURI DAM SAFETY
T2        OVERTOP RATING CURVE
T3         ELEANOR LAKE DAM

J1  ICHECK     INQ       NINV      IDIR      STRT      METRIC    HVINS     Q         WSEL      FQ

      -1.        2.        3.        0. -1.000000     0.00      0.0       0.    704.200     0.000

J2  NPROF     IPLOT     PREVS     XSECV     XSECH     FN        ALLDC     IBW       CHNIM     ITRACE

     1.000     3.000    -1.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000

J3  VARIABLE CODES FOR SUMMARY PRINTOUT

    38.000     4.000    25.000     4.000    26.000    13.000    43.000     3.000     5.000    17.000

J5  LPRNT     NUMSEC                  *********REQUESTED SECTION NUMBERS*********

   -10.000   -10.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000
NC      .030      .030      .030     0.000     0.000     0.000     0.000     0.000     0.000     0.000
QT    10.000    40.000    50.000   100.000   200.000   300.000   400.000   500.000   750.000  1000.000
QT  1500.000  2000.000  2500.000  3000.000  4000.000     0.000     0.000     0.000     0.000     0.000

X1     1.000     6.000     0.000   320.000     0.000     0.000     0.000     0.000     0.000     0.000
GR   800.000     0.000   708.200     0.000   703.200    76.000   703.200   205.000   715.700   320.000
GR   800.000   320.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000     0.000

X1     2.000     0.000     0.000     0.000    35.300    35.000    35.000     0.000     0.000     0.000
EJ     0.000     0.300     0.600     0.000     0.000     0.000     0.000     0.000     0.000     0.000
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*********************************************
  HEC2 RELEASE DATED NOV 76 UPDATED APRIL 1980
  ERROR CORR - 01,02,03,04
  MODIFICATION - 50,51,52,53,54
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NOTE- ASTERISK (*) AT LEFT OF CROSS-SECTION NUMBER INDICATES MESSAGE IN SUMMARY OF ERRORS LIST

ELEANOR LAKE DAM

SUMMARY PRINTOUT

	SECNO	DEPTH	AREA	TOPWID	VCH	QLOB	Q	EG	10K*S	K*XNCH
*	1.000	.14	19.96	136.22	2.11	0.00	40.00	703.41	256.39	30.00
*	1.000	.16	22.00	138.73	2.27	0.00	50.00	703.44	245.20	30.00
*	1.000	.26	35.24	140.93	2.84	0.00	100.00	703.58	208.31	30.00
*	1.000	.43	56.18	144.33	3.56	0.00	200.00	703.80	181.87	30.00
*	1.000	.53	74.09	147.18	4.05	0.00	300.00	703.98	166.95	30.00
*	1.000	.63	90.27	149.71	4.43	0.00	400.00	704.14	157.21	30.00
*	1.000	.73	105.43	152.04	4.74	0.00	500.00	704.28	149.45	30.00
*	1.000	.96	139.99	157.23	5.36	0.00	750.00	704.60	136.66	30.00
*	1.000	1.15	171.12	161.76	5.84	0.00	1000.00	704.88	129.23	30.00
*	1.000	1.50	228.02	169.72	6.58	0.00	1500.00	705.37	119.10	30.00
*	1.000	1.79	279.03	176.56	7.17	0.00	2000.00	705.79	113.88	30.00
*	1.000	2.06	327.32	182.79	7.64	0.00	2500.00	706.17	109.48	30.00
*	1.000	2.31	373.43	188.55	8.03	0.00	3000.00	706.51	105.91	30.00
*	1.000	2.77	462.62	199.23	8.65	0.00	4000.00	707.13	99.25	30.00
	2.000	.33	45.57	142.62	.88	0.00	40.00	703.54	14.38	30.00
	2.000	.36	51.28	143.54	.97	0.00	51.00	703.58	15.29	30.00
	2.000	.51	72.51	146.93	1.38	0.00	100.00	703.74	17.89	30.00
	2.000	.73	104.43	151.89	1.92	0.00	200.00	703.98	24.65	30.00
	2.000	.89	128.93	155.59	2.33	0.00	300.00	704.18	28.37	30.00
	2.000	1.04	151.80	158.96	2.64	0.00	400.00	704.34	30.12	30.00
	2.000	1.16	172.24	161.92	2.90	0.00	500.00	704.49	31.66	30.00
	2.000	1.43	217.85	168.32	3.44	0.00	750.00	704.82	34.29	30.00
	2.000	1.67	257.28	175.67	3.89	0.00	1000.00	705.10	36.50	30.00
	2.000	2.07	329.82	182.38	4.55	0.00	1500.00	705.59	38.87	30.00
	2.000	2.41	393.95	191.06	5.08	0.00	2000.00	706.01	40.09	30.00
	2.000	2.71	451.51	197.35	5.54	0.00	2500.00	706.39	41.60	30.00
	2.000	2.99	507.18	[illegible]	5.92	0.00	3000.00	706.73	42.51	30.00
	2.000	3.5[illegible]	[illegible]	[illegible]	[illegible]	0.00	4000.00	707.3[illegible]	43.7[illegible]	30.00

```
SUMMARY OF ERRORS

CAUTION  SECNO=    1.000  PROFILE= 1  CRITICAL DEPTH ASSUMED
CAUTION  SECNO=    1.000  PROFILE= 2  CRITICAL DEPTH ASSUMED
CAUTION  SECNO=    1.000  PROFILE= 3  CRITICAL DEPTH ASSUMED
CAUTION  SECNO=    1.000  PROFILE= 4  CRITICAL DEPTH ASSUMED
CAUTION  SECNO=    1.000  PROFILE= 5  CRITICAL DEPTH ASSUMED
CAUTION  SECNO=    1.000  PROFILE= 6  CRITICAL DEPTH ASSUMED
CAUTION  SECNO=    1.000  PROFILE= 7  CRITICAL DEPTH ASSUMED
CAUTION  SECNO=    1.000  PROFILE= 8  CRITICAL DEPTH ASSUMED
CAUTION  SECNO=    1.000  PROFILE= 9  CRITICAL DEPTH ASSUMED
CAUTION  SECNO=    1.000  PROFILE=10  CRITICAL DEPTH ASSUMED
CAUTION  SECNO=    1.000  PROFILE=11  CRITICAL DEPTH ASSUMED
CAUTION  SECNO=    1.000  PROFILE=12  CRITICAL DEPTH ASSUMED
CAUTION  SECNO=    1.000  PROFILE=13  CRITICAL DEPTH ASSUMED
CAUTION  SECNO=    1.000  PROFILE=14  CRITICAL DEPTH ASSUMED
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SUMMARY OF PMF AND ONE-HALF PMF ROUTING

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**********************************
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION       JULY 1978
  LAST MODIFICATION  01 APR 80
**********************************
                   A1                 MISSOURI DAM SAFETY
                   A2                  MARIAN LAKE DAM
                   A3                   PMF AND 50 PERCENT PMF
                   B    300      0        5        0        0        0        0        0        0        0
                   B1     5
                   J      1      2        1
                   J1   0.5      1
                   K       DA ELLIE                                         1
                   K1      RUNOFF CALCULATION FOR ELEANOR LAKE DRAINAGE AREA
                   M      1      2     0.17             0.17        1                          1
                   P          24.8      100      120      130
                   T                                                      -1      -91
                   W2         0.10
                   X                      1
                   K      1ELLIE DM                                         1
                   K1      ROUTE HYDROGRAPH THROUGH ELEANOR LAKE DAM
                   Y                               1        1
                   Y1     1                                              -699.8    -1
                   Y4 703.2  703.5    703.6    703.7      704    704.2    704.3    704.5    704.8    705.1
                   Y4 705.6    706    706.4    706.7
                   Y5     0     40       50      100      200      300      400      500      750     1000
                   Y5  1500   2000     2500     3000     4000
                   $S     0     11     29.5       48       90    150.5      272    400.5      510    780.5
                   $E   680    690    699.8    703.2      710      720      730      740      750      760
                   $$ 703.2
                   $D 703.2
                   $B    10    0.5    686.5        1    699.8    703.2
                   K       DA MARN                                          1
                   K1      RUNOFF CALCULATION FOR MARIAN LAKE DRAINAGE AREA
                   M      1      2     0.06             0.06        1                          1
                   P          24.8      100      120      130
                   T                                                      -1      -91
                   W2        0.012
                   X                      1
```

```
K       2U/S MRN                                                                 1
K1       COMBINE ELEANOR LAKE AND MARIAN LAKE RUNOFF
K       1 MARN DM                                                                1
K1       ROUT HYDROGRAPH THROUGH MARIAN LAKE
Y                                       1       1
Y1      1
Y4  669.6   670.8   670.9   671.2   671.7   672.2  -669.6      -1
Y4  674.6   675.6   676.6   677.6                   672.6   673.3   673.6     674
Y5      0      11      15      24      42      65      79      99     140     668
Y5   1384    3574    6527   10118
$S      0      15    52.5   118.5     147   223.5     326   513.5
$E    640     650     660   669.6   673.5     680     690     700
$$  669.6
$D  673.5
K      99
```

SUMMARY OF DAM SAFETY ANALYSIS

1 ....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	69[illegible].80	703.20	703.20
STORAGE	30.	48.	48.
OUTFLOW	0.	0.	0.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.50	703.28	.08	48.	509.	.35	11.92	11.17
1.00	703.38	.18	49.	1929.	.44	15.75	8.58

1 ....

SUMMARY OF DAM SAFETY ANALYSIS

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	665.60	669.60	673.50
STORAGE	119.	119.	147.
OUTFLOW	0.	0.	126.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.50	674.28	.78	156.	1004.	6.50	15.83	0.00
1.00	675.04	1.54	165.	2337.	8.67	15.75	0.00

AD-A104 968 PRC CONSOER TOWNSEND INC ST LOUIS MO F/G 13/13
NATIONAL DAM SAFETY PROGRAM. MARIAN LAKE DAM (MO 30016), MISSOU--ETC(U)
MAY 81 W G SHIFRIN DACW43-80-C-0094
UNCLASSIFIED NL

2 OF 2
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END
DATE
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10 81
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PERCENT OF PMF ROUTING
EQUAL TO SPILLWAY CAPACITY

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***********************************
FLOOD HYDROGRAPH PACKAGE (HEC-1)
DAM SAFETY VERSION       JULY 1978
  LAST MODIFICATION   11 APR 80
***********************************
A1                    MISSOURI DAM SAFETY
A2                     MARIAN LAKE DAM
A3          PERCENT PMF
B      300       0       5       0       0       0       0       0      -4       0
B1       5
J        1       9       1
J1     .01     .02     .03     .04     .05     .06     .07     .08     .09
K        DA ELLIE                                        1
K1       RUNOFF CALCULATION FOR ELEANOR LAKE DRAINAGE AREA
M        1       2    0.17            0.17       1                       1
P             24.8     110     120     130
T                                                       -1     -91
W2            0.10
X                        1
K       1ELLIE DM                                        1
K1       ROUTE HYDROGRAPH THROUGH ELEANOR LAKE DAM
Y                                1       1
Y1       1                                          -699.8      -1
Y4   703.2   703.5   703.6   703.7     704   704.2   704.3   704.5   704.8   705.1
Y4   705.6     706   706.4   706.7
Y5       0      40      50     100     200     300     400     500     750    1000
Y5    1500    2000    2500    3000    4000
$S       0      11    29.5      48      90   150.5     272   400.5     510   780.5
$E     680     690   695.8   703.2     710     720     730     740     750     760
$$   703.2
$D   703.2
$B      10     0.5   686.5       1   699.8   703.2
K        DA MARN                                         1
K1       RUNOFF CALCULATION FOR MARIAN LAKE DRAINAGE AREA
M        1       2    0.06            0.06       1                       1
P             24.8     100     120     130
T                                                       -1     -91
W2           0.012
X                        1
```

```
 35   K      2U/S MRN                                        1
 36   K1       COMBINE ELEANOR LAKE AND MARIAN LAKE RUNOFF
 37   K      1 MARN DM                                       1
 38   K1       ROUT HYDROGRAPH THROUGH MARIAN LAKE
 39   Y
 40   Y1     1                                          -669.6        -1
 41   Y4 669.6    670.8    670.9    671.2    671.7    672.2    672.6    673.3    673.6    674
 42   Y4 674.6    675.6    676.6    677.6
 43   Y5     0       11       15       24       42       65       79       99      140    668
 44   Y5  1384     3574     6527    10118
 45   $S     0       15     52.5    118.5      147    223.5      326    513.5
 46   $E   640      650      660    669.6    673.5      680      690      700
 47   $$ 669.6
 48   $D 673.5
 49   K     99
```

SUMMARY OF DAM SAFETY ANALYSIS

1 ....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	699.80	703.20	703.20
STORAGE	30.	48.	48.
OUTFLOW	0.	0.	0.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.01	700.32	0.00	32.	0.	0.00	0.00	0.00
.02	700.84	0.00	35.	0.	0.00	0.00	0.00
.03	701.35	0.00	38.	0.	0.00	0.00	0.00
.04	701.87	0.00	41.	0.	0.00	0.00	0.00
.05	702.39	0.00	44.	0.	0.00	0.00	0.00
.06	702.90	0.00	46.	0.	0.00	0.00	0.00
.07	703.22	.02	48.	648.	.25	18.73	18.00
.08	703.26	.06	48.	881.	.33	17.56	16.83
.09	703.29	.09	49.	[illegible]92.	.35	16.81	16.08

SUMMARY OF DAM SAFETY ANALYSIS

1 ....

	INITIAL VALUE	SPILLWAY CREST	TOP OF DAM
ELEVATION	669.60	669.60	673.50
STORAGE	119.	119.	147.
OUTFLOW	0.	0.	126.

RATIO OF PMF	MAXIMUM RESERVOIR W.S.ELEV	MAXIMUM DEPTH OVER DAM	MAXIMUM STORAGE AC-FT	MAXIMUM OUTFLOW CFS	DURATION OVER TOP HOURS	TIME OF MAX OUTFLOW HOURS	TIME OF FAILURE HOURS
.01	669.69	0.00	119.	1.	0.00	18.00	0.00
.02	669.78	0.00	120.	2.	0.00	18.00	0.00
.03	669.87	0.00	120.	2.	0.00	18.00	0.00
.04	669.96	0.00	121.	3.	0.00	18.00	0.00
.05	670.05	0.00	122.	4.	0.00	18.00	0.00
.06	670.14	0.00	122.	5.	0.00	18.00	0.00
.07	673.81	.31	151.	416.	.67	19.08	0.00
.08	673.88	.38	151.	512.	.75	17.83	0.00
.09	673.90	.40	152.	542.	.83	17.08	0.00

END

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